Complete Service Manual coverage for late model year Mercedes-Benz vehicles requires three individual manuals:

Service Manual, Engine
Service Manual, Transmission
Service Manual, Chassis and Body

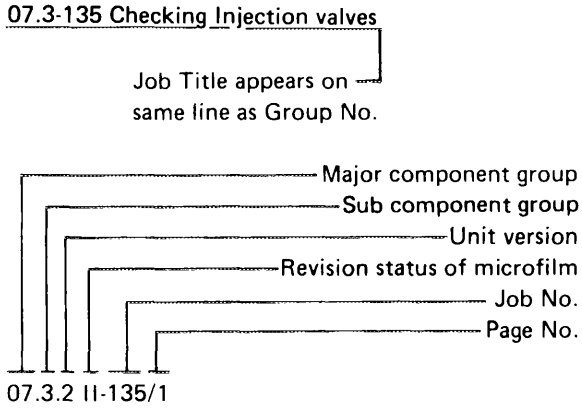
Throughout these manuals, the vehicles are identified by their chassis and engine numbers. These numbers are made up of the first six digits of the respective serial number. For the actual location of Chassis number and Engine number, see page 00–010/1. In cases where the repair instructions apply to all versions of the engine, only the first three digits of the respective number are referenced.

For example, engine 110 applies to all 2.8 liter 6 cylinder engines with dual overhead camshafts.

See the **engine and vehicle identification** table on page 00–010/1 for the engine installed in your vehicle.

**Location of specific repair instructions**

First locate the major component group in the Group Index. Individual groups are separated by an easily visible dividing page, which is followed by the job index page. Then check the job index for the exact job required. The first page of a typical job description looks like this:




Technical data, tightening torques and tools are listed at the beginning of each Job.

All the dimensions are in metric units, provided no other unit of measure is used. The indicated part numbers are serving exclusively for identification and better differentiation of individual versions. When odering spare parts, always use part numbers from the latest parts literature.

# 00 Engine number and vehicle indentification tag location

### Installation Survey

**6-Cylinder in-line engine with dual two-stage carburetor.**

| Model | Chassis type | Engine type |
|---|---|---|
| 280 | 114.060 | 110.921 |
| 280 C | 114.073 | 110.921 |
| 280 S | 116.020 | 110.922 |

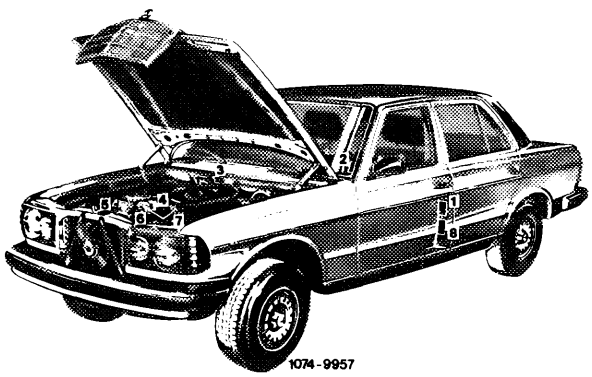
**Engines with CIS (Continuous Injection System)**

| Model | Chassis type | Engine type |
|---|---|---|
| 280 E | 123.033 | 110.984 |
| 280 CE | 123.053 | 110.984 |
| 280 SE | 116.024 | 110.985 |

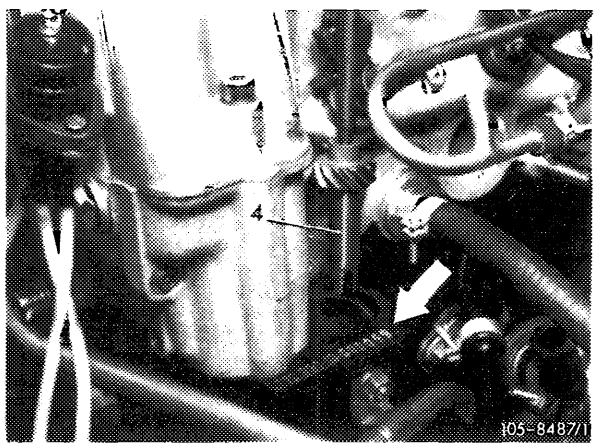
### Identification of Vehicle

**When ordering spare parts, please quote chassis and engine numbers.**

With your MERCEDES-BENZ you receive two vehicle data cards listing all major vehicle data.




1 Certification Tag (left door pillar)
2 Identification Tag (left window post)
3 Chassis No.
4 Engine No.
5 Body No. and Paintwork No.
6 Information Tag
California Version
Vacuum line routing for emission control system
7 Emission Control Tag
8 Emission Control Tag
Catalyst Information




Engine No. stamped on left front of cylinder block (arrow)

**Engine**

| | | | | | |
|---|---|---|---|---|---|
| Model | | 280 | 280 C | 280 S | |
| Chassis Type | | 114.060 | 114.073 | 116.020 | |
| Engine Type | | 110.921/922 | | | |
| Year | | 1976 | 1975 | 1974 | 1973 |
| Operation | | Four stroke, gasoline engine with carburetor | | | |
| Number of cylinders | | 6 | | | |
| Arrangement of cylinders | | upright in line | | | |
| Bore/stroke | mm(ins.) | 86/78 (3.39/3.10) | | | |
| Total eff. piston displacement | $cm^3$ (cu. ins.) | 2746 (167.6) | | | |
| Compression ratio | | 9 : 1 | 8 : 1 | 9 : 1 | 8 : 1 |
| Firing order | | 1-5-3-6-2-4 | | | |
| Max. engine rpm | | 6500 | | | |
| Engine output | SAE net bhp/rpm | 160/5500 | 145/5500 | 160/5500 | 130/5000 |
| Max. torque | SAE net ft. lb/rpm | 165/4000 | 154/4000 | 165/4000 | 150/3500 |
| Crankshaft bearings | | 7 | | | |
| Valve arrangement | | overhead | | | |
| Camshaft arrangement | | DOHC | | | |
| Oil cooling | | None | | | |
| Cooling | | Water circulation pump, thermostat with by-pass line, finned tube radiator, fan with viscous coupling | | | |
| Lubrication | | Forced oil circulation via gear-type oil pump | | | |
| Oil filter | | Full-flow filter | | | |
| Air filter | | Air filter with paper cartridge | | | |

**Filling Capacities**

| Model | | | 280 | 280 C | 280 S | |
|---|---|---|---|---|---|---|
| Chassis Type | | | 114.060 | 114.073 | 116.020 | |
| Engine Type | | | 110.921/922 | | | |
| Year | | | 1976 | 1975 | 1974 | 1973 |
| Engine | Initial filling | Engine oil approx. ltr. (US qt) | 7 (7.4) | | | |
| | Oil and filter change | Engine oil approx. ltr. (US qt) | 6.5 (6.9) | | | |
| | Oil pan up to max. marking on oil dipstick | Engine oil max. ltr. (US qt) | 6 (6.3) | | | |
| | Oil filter | Engine oil approx. ltr. (US qt) | 0.6 (0.62) | | | |
| Cooling system with heater | | Coolant approx. ltr. (US qt) | 11 (11.6) | 10.5 (11)* | | 11 (11.6) |
| Water pump | | | maintenance free | | | |
| Brake system | | Brake fluid approx. ltr. (US qt) | 0.5 (0.53) | | | |
| Autom. Transmission | Initial filling/ fluid change | Autom. transmission fluid (ATF) approx. ltr. (US qt) | 6.6/5.3 (7.0/5.6) | | | |
| Power steering | | Autom transmission fluid (ATF) approx. ltr. (US qt) | 1.4 (1.5) | | | |

*110.922 (280 S) = 11 ltr./11.6 qt

**Engine**

| | | | | | |
|---|---|---|---|---|---|
| Model | | 280 E | 280 CE | 280 SE | |
| Chassis Type | | 123.033 | 123.053 | 116.024 | |
| Engine Type | | 110.984/985 | | | |
| Year | | 1980/1981 | 1979 | 1978 | 1977 |
| Operation | | Four stroke, gasoline engine, mechanical (CIS) fuel injection with airflow sensor | | | |
| Number of cylinders | | 6 | | | |
| Arrangement of cylinders | | upright in line | | | |
| Bore/stroke | mm (ins.) | 86/78 (3.39/3.10) | | | |
| Total eff. piston displacement | $cm^3$ (cu. ins.) | 2746 (167.6) | | | |
| Compression ratio | | 8 ± 0.4 : 1 | 8 : 1 | | |
| Firing order | | 1-5-3-6-2-4 | | | |
| Max. engine rpm | | 6400 | 6500 | | |
| Engine output | SAE net bhp/rpm | 140/5500 | 142/5750[1])<br>137/5750[2]) | | |
| Max. torque | SAE net ft. lb/rpm | 145/4500 | 149/4600[1])<br>142/4600[2]) | | |
| Crankshaft bearings | | 7 | | | |
| Valve arrangement | | overhead | | | |
| Camshaft arrangement | | DOHC | | | |
| Oil cooling | | None | | | |
| Cooling | | Water circulation pump, thermostat with by-pass line, finned tube radiator, fan with viscous coupling | | | |
| Lubrication | | Forced oil circulation via gear-type oil pump | | | |
| Oil filter | | Full-flow filter | | | |
| Air filter | | Air filter with paper cartridge | | | |

[1]) Federal
[2]) California

**Filling Capacities**

| Model | | | 280 E | 280 CE | 280 SE | |
|---|---|---|---|---|---|---|
| Chassis Type | | | 123.033 | 123.053 | 116.024 | |
| Engine Type | | | 110.984/985 | | | |
| Year | | | 1980/1981 | 1979 | 1978 | 1977 |
| Engine | Initial filling | Engine oil approx. ltr. (US qt) | 6.5 (6.9) | 7 (7.4) | | |
| | Oil and filter change | Engine oil approx. ltr. (US qt) | 6 (6.3) | 6.5 (6.9) | | |
| | Oil pan up to max. marking on oil dipstick | Engine oil max. ltr. (US qt) | 5.4 (5.7) | 6 (6.3) | | |
| | Oil filter | Engine oil approx. ltr. (US qt) | 0.6 (0.62) | | | |
| Cooling system with heater | | Coolant approx. ltr. (US qt) | 10 (10.6)* | | | |
| Water pump | | | maintenance free | | | |
| Brake system | | Brake fluid approx. ltr. (US qt) | 0.5 (0.53) | | | |
| Autom. Trans-mission | Initial filling/ fluid change | Autom. transmission fluid (ATF) approx. ltr. (US qt) | 6.6/5.3 (7.0/5.6) | | | |
| Power steering | | Autom transmission fluid (ATF) approx. ltr. (US qt) | 1.4 (1.5) | | | |

*110.985 (280 SE) = 11 ltr./11.6 qt

## 01–001 Engine and model survey

| Engine | Model | Sales designation | kW at 1/min |
|---|---|---|---|
| 110.921[1]) | 114.060 | 280 | 118/5500 |
| 110.921[1]) | 114.073 | 280 C | 118/5500 |
| 110.922[1]) | 116.020 | 280 S | 118/5500 |
| 110.923 | 123.030 | 280 | 115/5500 |
| 110.923 NV | 123.030 | 280 | 105/5500 |
| 110.923 | 123.050 | 280 C | 115/5500 |
| 110.923 NV | 123.050 | 280 C | 105/5500 |
| 110.924 | 126.021 | 280 S | 115/5500 |
| 110.924 NV | 126.021 | 280 S | 115/5500 |
| 110.931 NV | 114.060 | 280 | 107/5500 |
| 110.931 NV | 114.073 | 280 C | 107/5500 |
| 110.932 NV | 116.020 | 280 S | 107/5500 |
| 110.981 | 114.062 | 280 E | 136/6000 |
| 110.981 | 114.072 | 280 CE | 136/6000 |
| 110.982 | 107.022 | 280 SLC | 136/6000 |
| 110.982 | 107.042 | 280 SL | 136/6000 |
| 110.983 | 116.024 | 280 SE | 136/6000 |
| 110.983 | 116.025 | 280 SEL | 136/6000 |
| 110.984 | 123.007[2]) | 280 E Special body long | 130/6000 |
| 110.984[1]) | 123.033 | 280 E | 130/6000 |
| 110.984 | 123.053 | 280 CE | 130/6000 |
| 110.984 | 123.093 | 280 TE | 130/6000 |
| 110.985[1]) | 116.024 | 280 SE | 130/6000 |
| 110.985[1]) | 116.025 | 280 SEL | 130/6000 |
| 110.986 | 107.022 | 280 SLC | 130/6000 |
| 110.986 | 107.042 | 280 SL | 130/6000 |
| 110.987 | 126.022 | 280 SE | 136/5800 |
| 110.987 | 126.023 | 280 SEL | 136/5800 |
| 110.991 NV | 114.062 | 280 E | 125/6000 |
| 110.991 NV | 114.072 | 280 CE | 125/6000 |
| 110.992 NV | 107.022 | 280 SLC | 125/6000 |
| 110.992 NV | 107.042 | 280 SL | 125/6000 |
| 110.993 NV | 116.024 | 280 SE | 125/6000 |
| 110.993 NV | 116.025 | 280 SEL | 125/6000 |

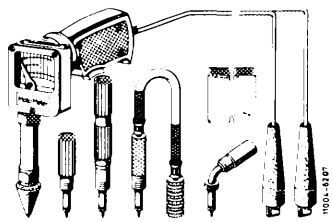
[1]) for USA
2) Sweden only
NV = low compression (SA 012.276)
SA = special equipment

## 01–010 Checking compression

**Test values in bar for engine at operating temperature**

| Engine | Compression ratio ε : 1 | Compression normal | Min. Compression | Max. difference between separate cylinders |
|---|---|---|---|---|
| Normal compression | 9,0 | 10–12 | approx. 8,5 | |
| Low compression | | | | max. 1,5 |
| (USA) (S) (J) starting 1976 (AUS) starting 1977 | 8,0 | 9–10 | approx. 7,5 | |

**Special tool**

| | | |
|---|---|---|
| Compression recorder with attachments and contact grip. |  | 001 589 46 21 00 |

**Notes**

Check compression with coolant at temperature of 80° C.

Check cylinders for leaks if compression is less than the minimum specification (01–015).

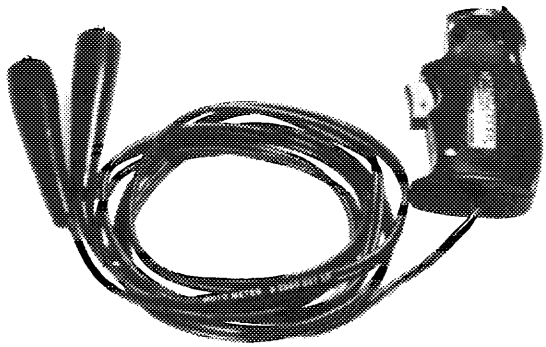
Unscrew all spark plugs for testing.

## Checking

### Models 107, 114 and 116

Connect contact handle to battery + and terminal 50 on starter.

Disconnect cable on ignition coil terminal 1.

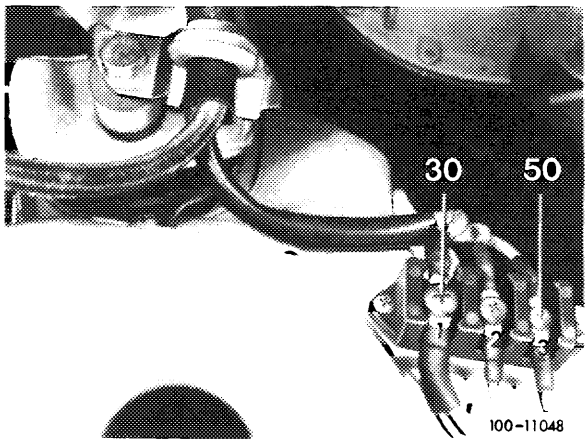


105-9061

### Model 123

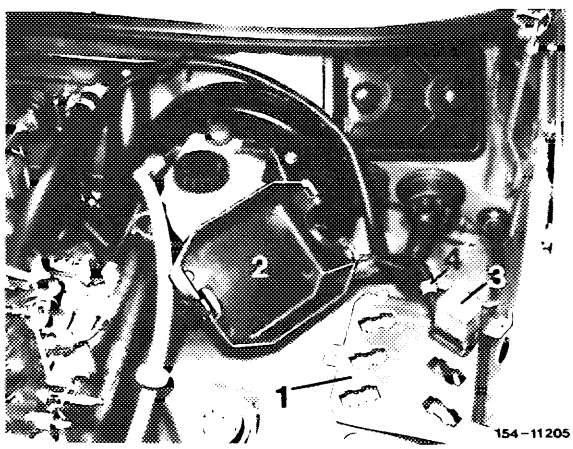
Connect contact handle to terminal 30 and to terminal 50 on cable connector.

Disconnect cable on ignition coil terminal 1.




100-11048

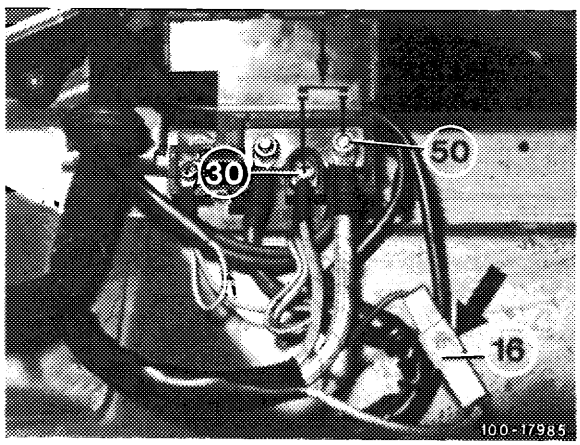
**Attention!**
On engines with CIS injection system, pull-off relay with code number 21 (3) for fuel pump—warm-up compensator.




154-11205

### Model 126

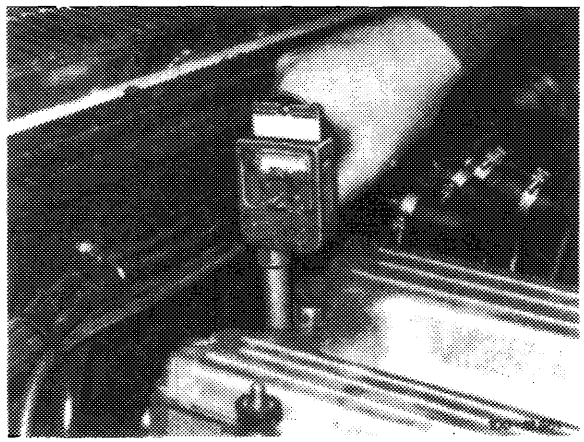
Separate cable plug, arrow terminal 16, so that the ignition coil, and on engines with CIS the fuel pump, cannot be activated. Connect terminal 30 and 50.




100-17985

1 Rotate engine for several turns with ignition switched off and idle speed or selector lever position „P" so that residue and soot will be blown out.

2 For testing, rotate engine for eight turns while opening throttle valve.

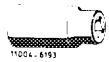


## 01–015 Checking cylinders for leaks

### Data

| | |
|---|---|
| Total pressure loss | max 25% |
| On valves and cylinder head gasket | max 10% |
| On piston and piston rings | max 20% |

### Special tool

| | | |
|---|---|---|
| Socket 27 mm for rotating engine |  | 001 589 65 09 00 |

### Conventional tool

| | |
|---|---|
| Cylinder leak tester | e.g. made by Bosch, EFAW 210 A<br>made by SUN, CLT 228 |

### Checking

1 Run engine up to operating temperature.

2 Unscrew spark plugs.

3 Remove radiator cap and add coolant.

4 Remove oil filler plug.

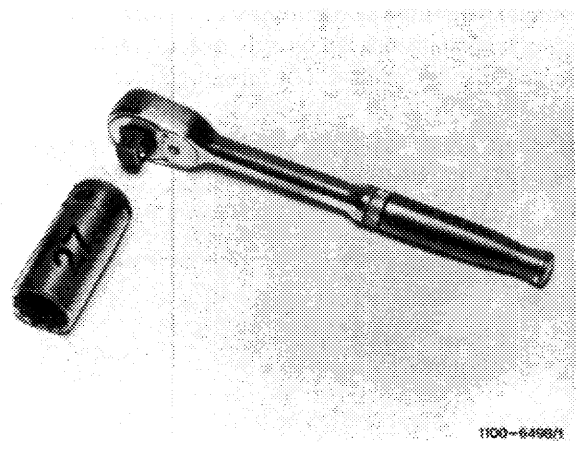
5 Remove air filter.

6 Connect cylinder leak tester to a compressed air source. Calibrate tester.

7 Set piston of cylinder 1 to ignition TDC.

For this purpose, turn engine on crankshaft by means of tool combination.

8 Set throttle valve to fully open.

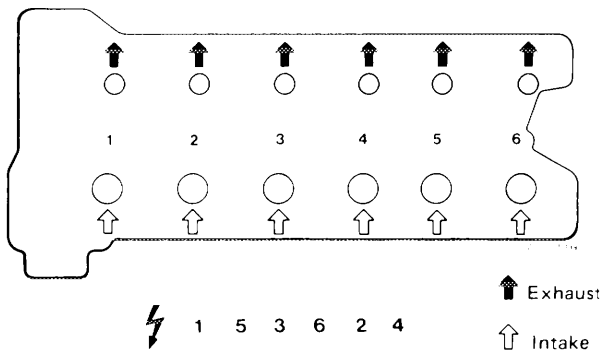


9 Screw connection hose into first spark plug bore and couple to connecting hose of tester. Crankshaft should not rotate.

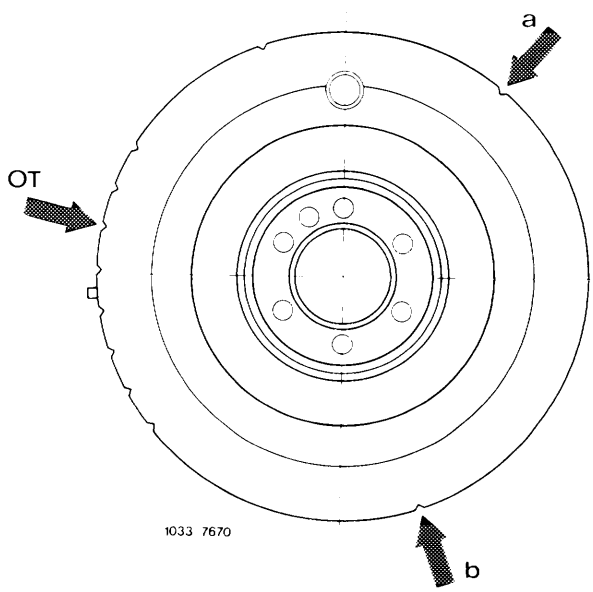
10 Read pressure loss on tester.

11 Check by listening whether pressure escapes via intake pipe, exhaust, oil filler cap, spark plug bore of adjacent cylinder or radiator cap.

12 Check all cylinders in ignition sequence.




**Note:** The respective pistons are in TDC position when the markings on vibration damper as shown in adjacent drawing are below TDC indicator.




TDC position of pistons

TDC Piston 1 and 6
a Piston 3 and 4
b Piston 2 and 5

**Note:** There is the possibility that the piston ring gaps of individual pistons are directly one above the other, so that the test result will be misrepresented.

When in doubt, continue running vehicle and check cylinders for leaks once again later on.

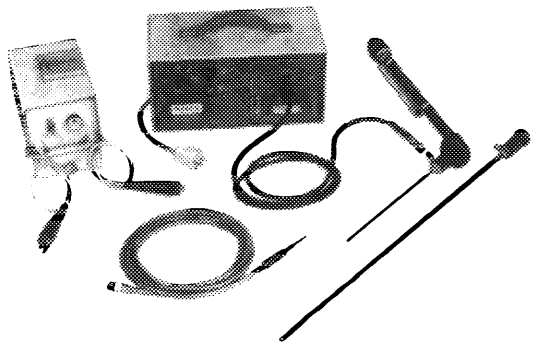
**Conventional tool**

| | |
|---|---|
| Cylinder illuminating lamp | e.g. made by Karl Storz GmbH, 7200 Tuttlingen Motoskop TW (cold light) with lens attachment 210 mm long. |

**Note**

Visual inspections can be made with a cylinder illuminating lamp on mounted cylinder head.

When illuminating because of oil consumption or blue smoke, run engine warm, shut off and illuminate cold, or immediately following deceleration (coasting).



103-15713

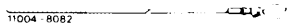
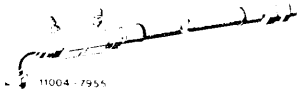
When evaluating scored or streaky cylinder walls, it is often no easy job for a workshop to decide whether the respective damage is bad enough to require removal of engine or repairs, or whether the marks are insignificant. The following information will help in making an expert and correct decision.

With regard to marks on cylinder walls the first important difference is between "optical streaks" and "seizure streaks". In most cases "optical streaks" are about 3 mm wide, they are produced by the piston ring gaps and the honing structure will still be visible; while "seizure streaks" will obliterate the honing structure.

"Longitudinal streaks" (in piston pin direction) are not the result of shaft scratches or seizure, since there is no contact between piston skirt and cylinder wall.

# 01–025 Measuring oil consumption

## Special tools

| | | |
|---|---|---|
| Oil dipstick with millimeter scale for engines with oil suction | | 115 589 15 21 00 |
| Oil dipstick with millimeter scale for engines without oil suction |  | 110 589 11 21 00 |
| Telethermometer | | 116 589 27 21 00 |
| Valve for interrupting oil return flow from oil cooler |  | 110 589 00 91 00 |

## Note

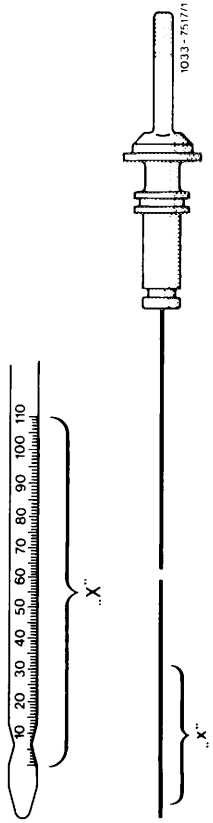
The oil consumption can be measured by means of oil dipstick with millimeter scale and the pertinent diagram on back of data sheet.

## Data sheets

| Engine 110 | Print no. |
|---|---|
| Engines with oil suction | 800 99 403 00<br>German/English<br>800 99 403 01<br>French/Spanish |
| Engines without oil suction | 800 99 227 00 a<br>German/English<br>800 99 227 01 a<br>French/Spanish |

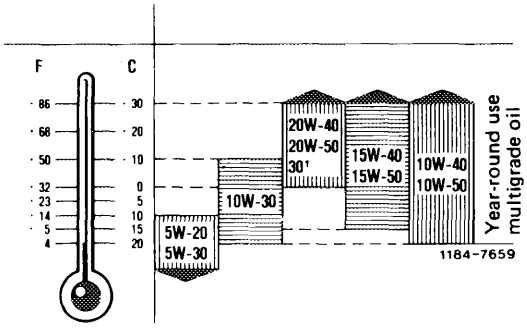
The measuring procedure is explained on front page of data sheet.

To avoid faulty measuring, check engine oil for dilution by fuel prior to measuring.



## 01–030 Removal and installation of engine (oil filling capacity)

Specified viscosity classes
according to SAE
during constant outside temperatures



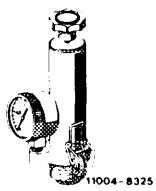
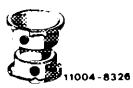
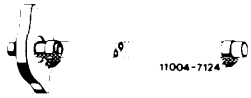

¹) During constant outside temperatures above + 30°C (+ 86° F) SAE 40 may be used.

**Oil filling capacity in liters (for approved engine oil grades refer to specifications for service products)**

| Color code of oil dipstick | total capacity when refilling engine |
|---|---|
| Wine red<br>pink<br>brown (USA 1975/76 only) | 7 |
| yellow-green | 6.5 |

| **Tightening torques** | | Nm |
|---|---|---|
| Oil drain plug to oil pan | | 40 |
| Fastening screw for oil filter lower half | | 40 |
| Screws for engine carrier on engine mount front | M 12 | 70 |
| | M 10 | 40 |

**Special tools**

| | | |
|---|---|---|
| Tester for cooling system and radiator cap |  11004-8325 | 001 589 48 21 00 |
| Double connection for radiator cap test in combination with tester |  11004-8326 | 000 589 73 63 00 |
| Radiator cap with hose for leak test |  11004-7124 | 605 589 00 25 00 |

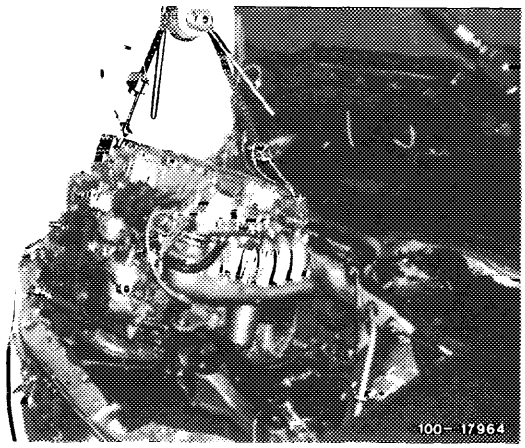
**Conventional tool**

| | |
|---|---|
| Engine hoist (Motordirigent) size 1.5 | e.g. made by Bäcker, D-5630 Remscheid order no. 3178 |

## Note

Remove and install engine with transmission by means of an engine hoist in diagonal position.

If removal and installation is performed on a lifting platform, the engine of model 126 can be placed on cross yoke center piece at the rear during installation.

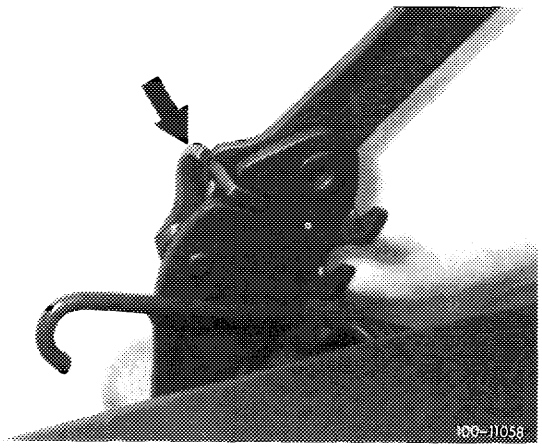



## Removal

1 On model 123 and 126 move engine hood into 90° position and let left-hand locking lever (arrow) engage.

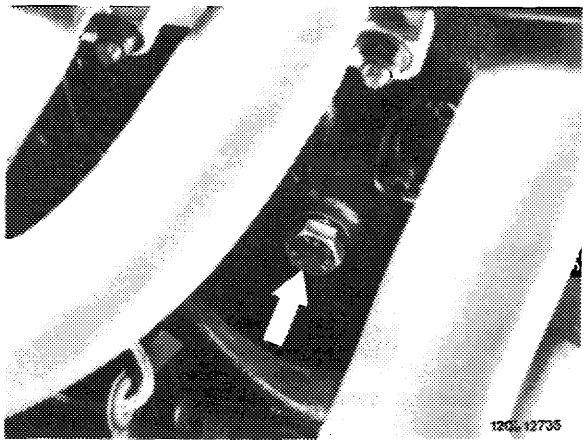
On other models, remove engine hood.

2 Disconnect battery cable.




3 Drain coolant (arrow).

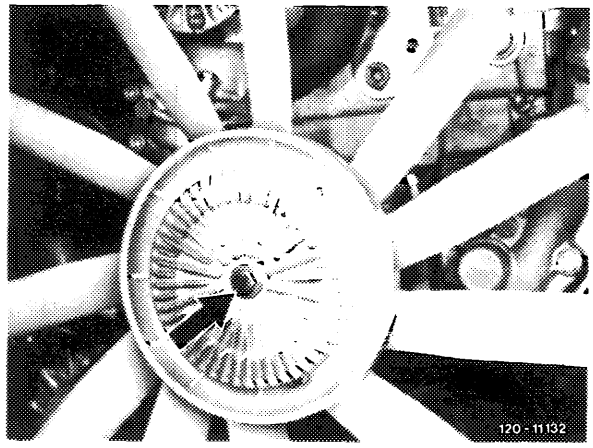
4 Disconnect and close lines for air oil cooler and transmission oil cooler on radiator and close, so that no oil will run out.




5 Remove radiator together with air oil cooler, while suspending fan cover over fan.

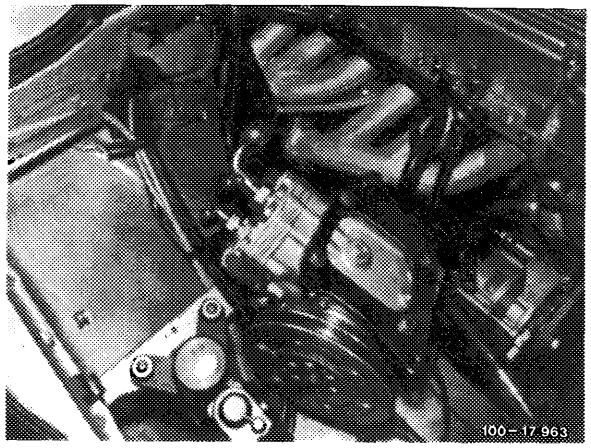
6 Remove fan.

For this purpose, loosen screw (arrow) on magnetic fan.

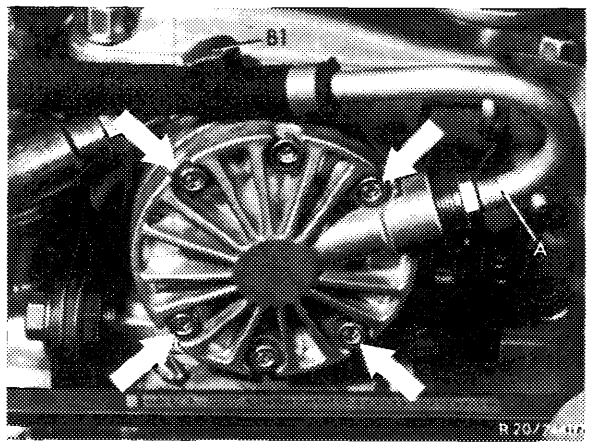



7 On vehicles with air conditioning, unscrew refrigerant compressor and put aside with lines connected.

When removing refrigerant compressor, drain air conditioning system (83–516).

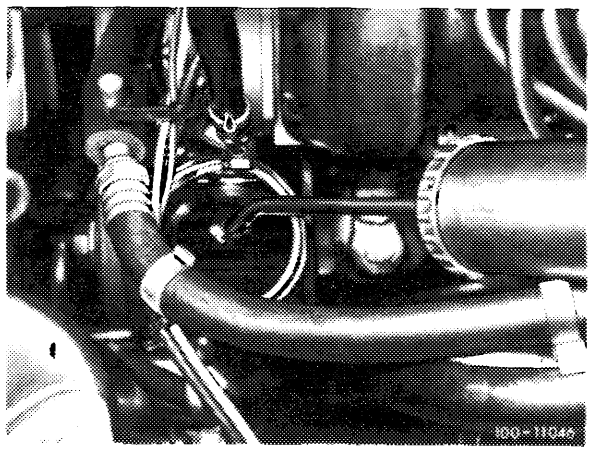



8 Disconnect lines at oil pressure pump. Only loosen bolts (arrows) to detach oil pressure pump.




9 Draw oil out of power steering pump tank.

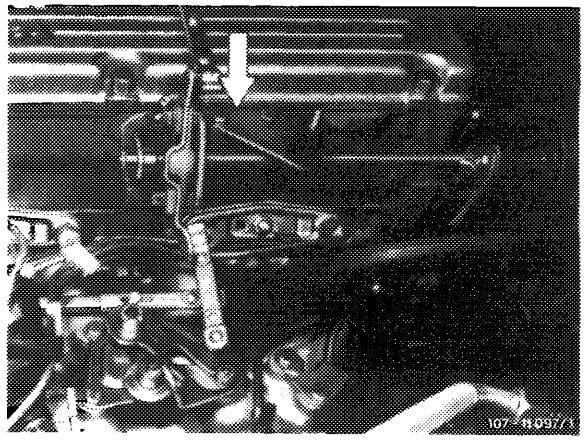
10 Disconnect hoses at power steering pump.



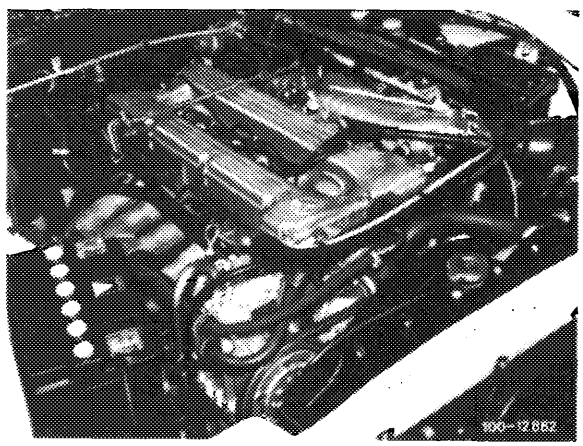
11 Disconnect electric harness for starter motor and alternator.

12 Disconnect all electric connections on engine.

13 Remove longitudinal control shaft.

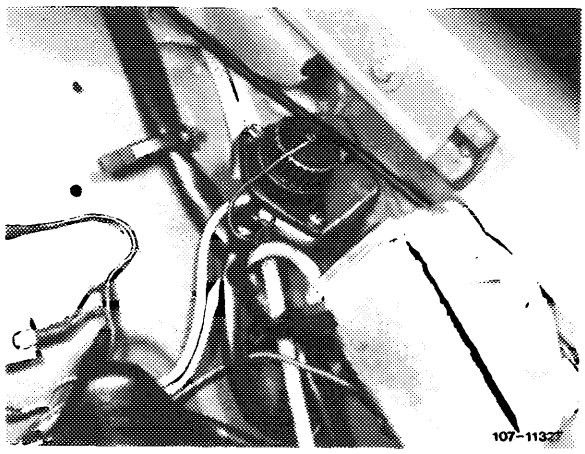


14 Disconnect all coolant, vacuum. oil and electric lines leading to the engine.

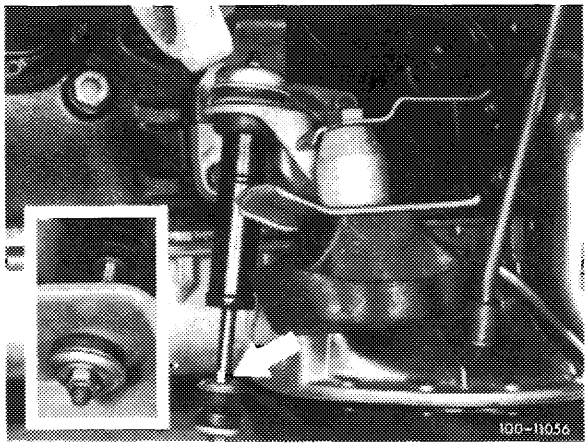


15 Pull off TDC transmitter wires at test socket. This requires unscrewing test socket at holder.

16 Detach exhaust pipes at exhaust manifold and exhaust strut at transmission.



17 Unscrew engine shock absorbers left and right (00–240).

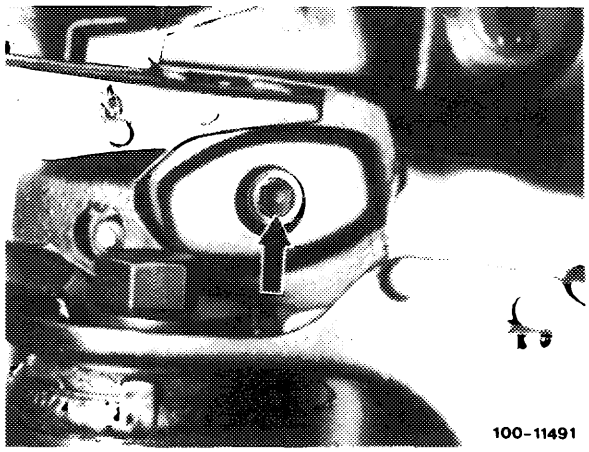



Model 123

18 Remove engine mounting bolts from engine mount.

Model 114 from above.

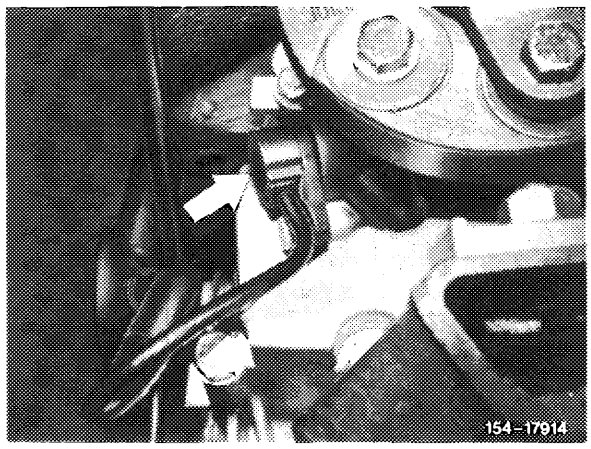
Models 107, 116, 123 and 126 from bottom of vehicle (arrow).




19 Remove rear engine carrier with engine mount.

20 Disconnect tachometer shaft on transmission.

Models with inductance transmitter (arrow): Disconnect inductance transmitter for tachometer. For this purpose, unscrew screw M 6 and pull out inductance transmitter.



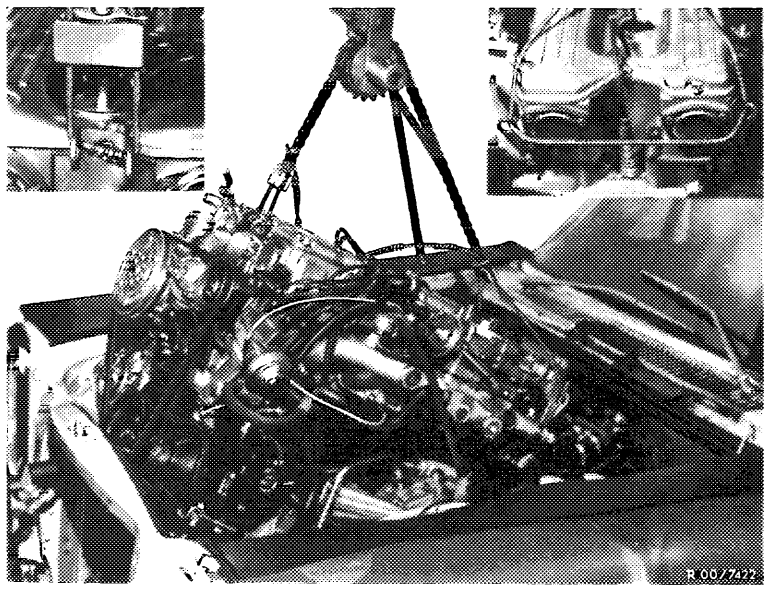
21 Disconnect propeller shaft on transmission and slide back.

Support propeller shaft, so that shaft will not abut against transmission flange when installing engine.

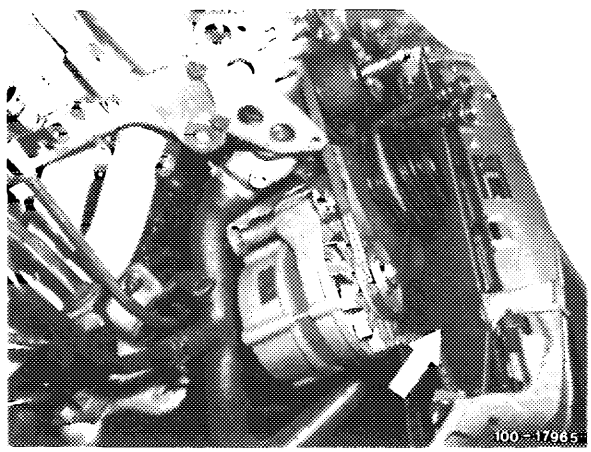
22 Loosen all connections and shift rods on transmission.

23 Attach engine at rear and front to suspension eyes.

24 Lift engine with transmission by means of engine hoist in an approx. 45° diagonal position. Make sure that the partition for unit compartment (model 126) is not damaged, since its damping effects will be lost by absorbed splash water.



**Attention!**
On vehicles with air conditioning, cover condenser with a hard fiber board (arrow).

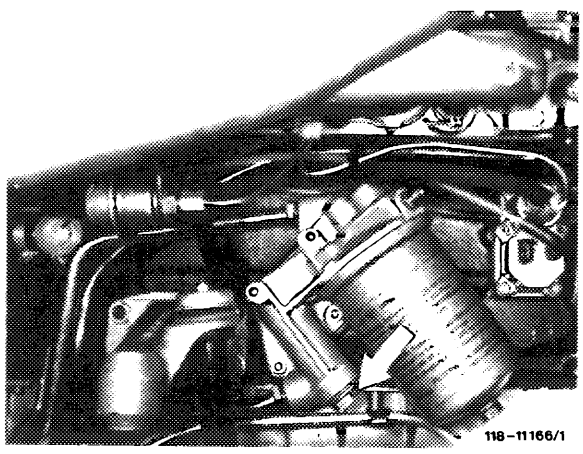



## Installation

**Attention!**
When installing an engine because of previous bearing damage, flush out the oil cooler and oil hoses. Clean oil filter housing.

25 Check engine mounts, engine shock absorbers, coolant, oil and fuel hoses and replace them if necessary.

26 Prior to flanging-on manual transmission, check radial ball bearing in crankshaft and throw-out of clutch and renew, if required.



27 Install engine and connect.

28 Adjust rear engine mount free of tension (00–220).

29 Connect propeller shaft.

30 Check all drain plugs for tight seat.

31 Add oil and coolant (20–010).

32 Check cooling system for leaks with leak tester.

**Note:** On vehicles with auxiliary heater, bleed coolant circuit (refer to repair instructions auxiliary heater 83–415).

33 Check coolant for antifreeze.

34 Clean air filter and renew, if required.

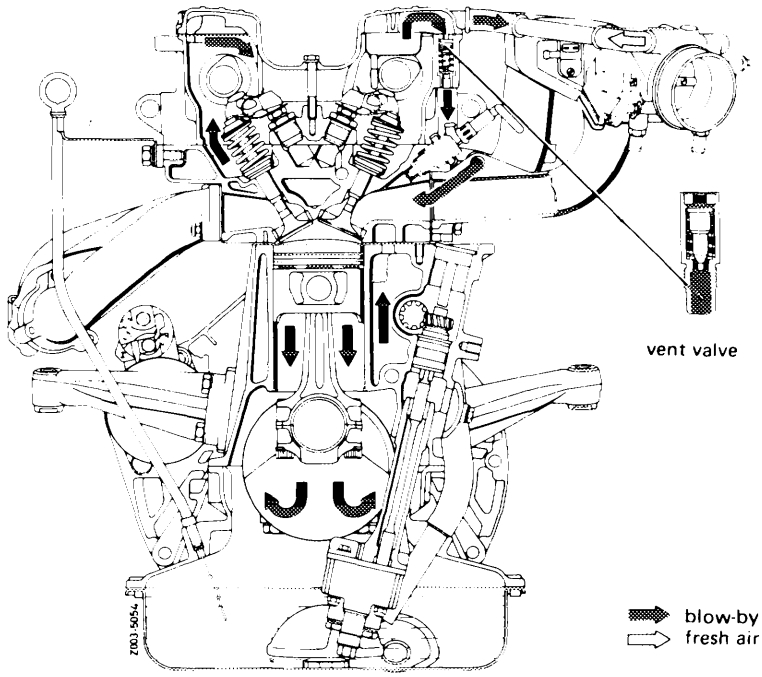
35 Check dwell angle and firing point.

36 Adjust idle speed and emission value (07.2–100).

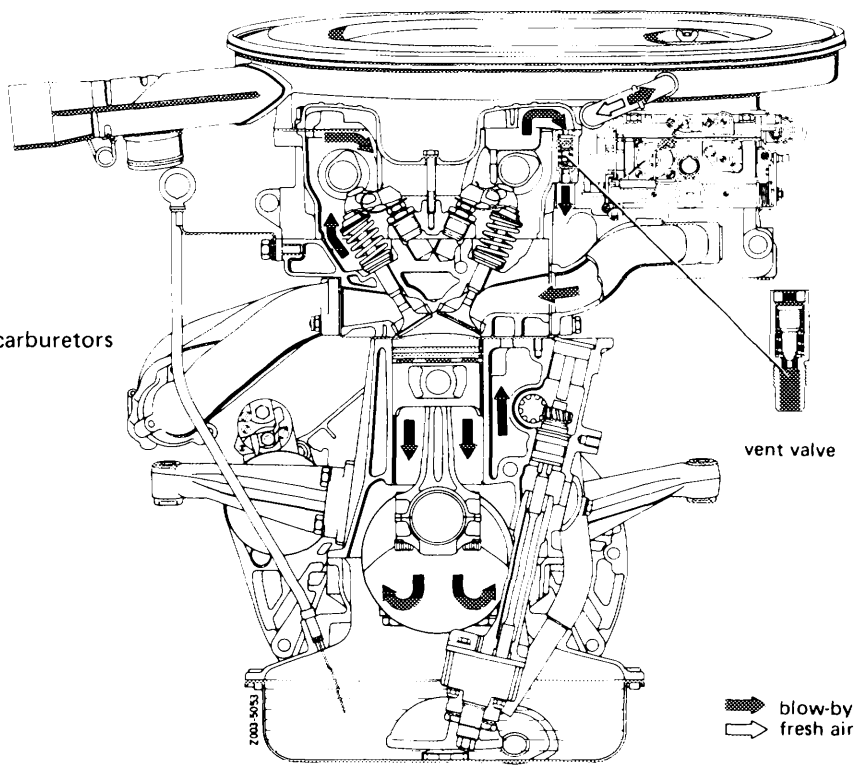
37 Check regulating shaft for function.

## A. Engine with vent valve

This engine has a closed crankcase vent system which does not require maintenance.




Engine with electronic fuel injection system.

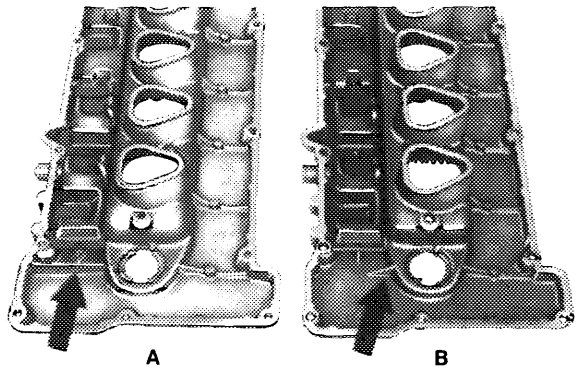



Engine with twin two-stage carburetors

First version with vent valve

The blow-by gases flow via an oil separator in the cylinder head cover to the vent valve.

**Attention!**
Only use cylinder head covers of version A with oil protection ribs.




101-9341

At idle speed and lower speed ranges the blow-by gas will enter the combustion chamber via the vent valve and intake manifold or idle air passage.

The vent valve spring works against the intake manifold vacuum pressure.

Depending on intake manifold vacuum pressure the valve cone will be pulled or pressed up by the valve spring and thus changes the through-flow cross section opening.

Since the through-flow capacity of the vent valve is larger than the amount of blow-by gas from the crankcase, fresh air is also drawn off from the air cleaner of a carburetor engine or from the throttle housing in front of the throttle valve via a pipe of an engine with fuel injection.

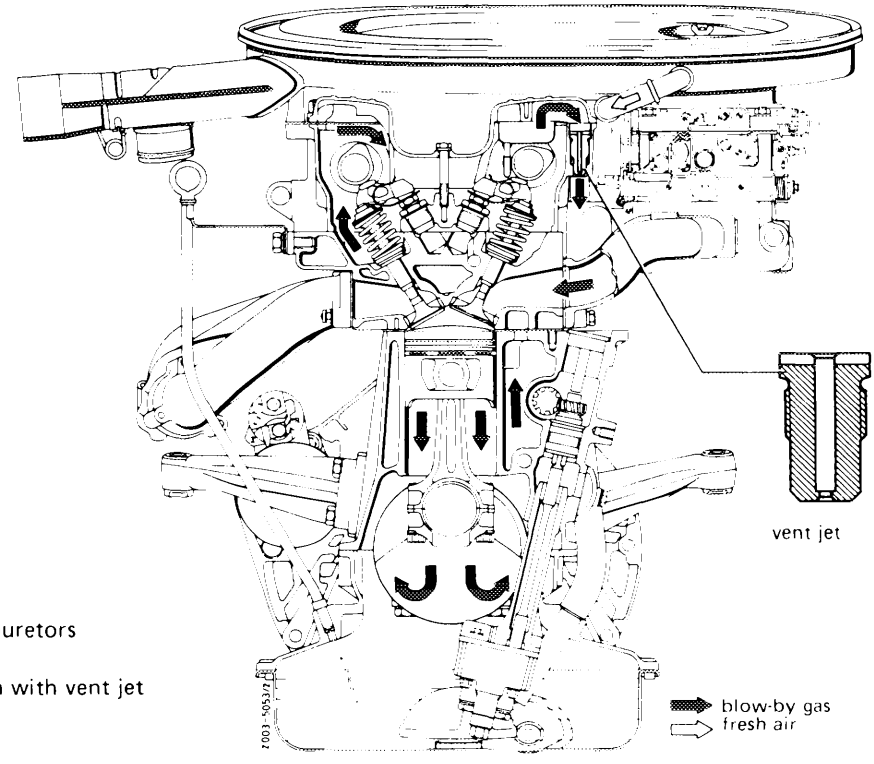
The additional fresh air is taken from an air cleaner of a carburetor engine via a hose.

When coasting the high intake manifold pressure will close the vent valve. The very slight amounts of blow-by gas in this case will now travel in reverse direction to the throttle housing via a pipe or the air cleaner via a hose and are drawn off at these points.

**Note:** Carburetor engines with a vent valve can also be equipped with a vent jet.

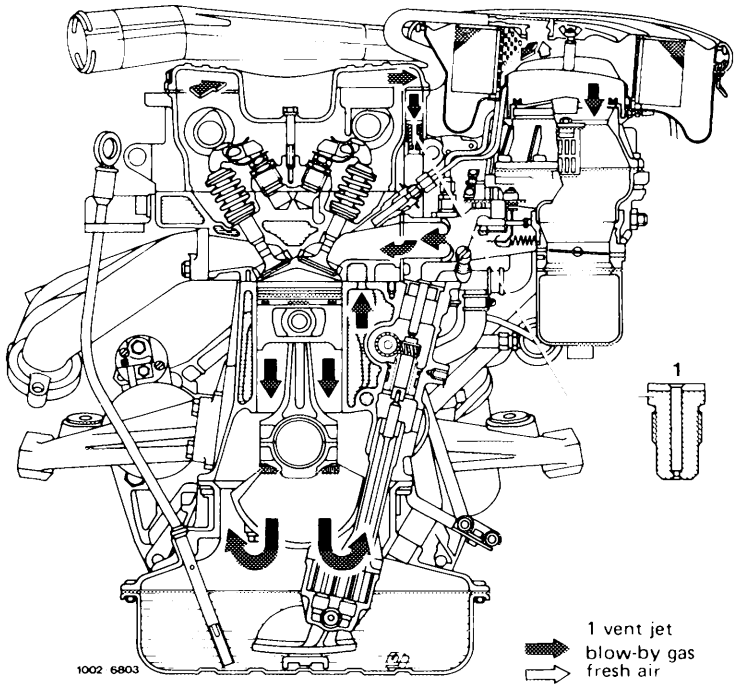
## B. Engine with vent jet

This engine has a closed crankcase vent which does not require maintenance.




Engine with twin two-stage carburetors

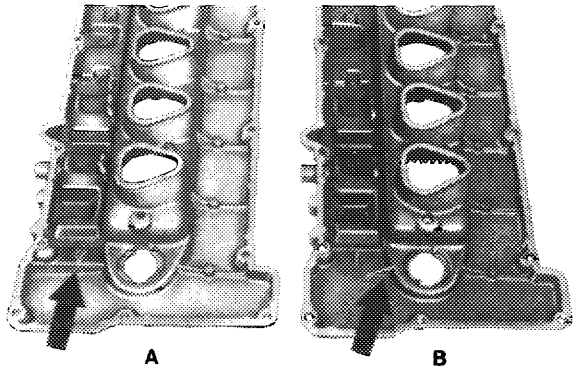
Second version and USA version with vent jet (including model year 1979).




Engine with continuous fuel injection

The blow-by gases flow to the vent jet via an oil separator in the cylinder head cover.

**Attention!**
Only use cylinder head covers of version A with oil protection ribs.




101-9341

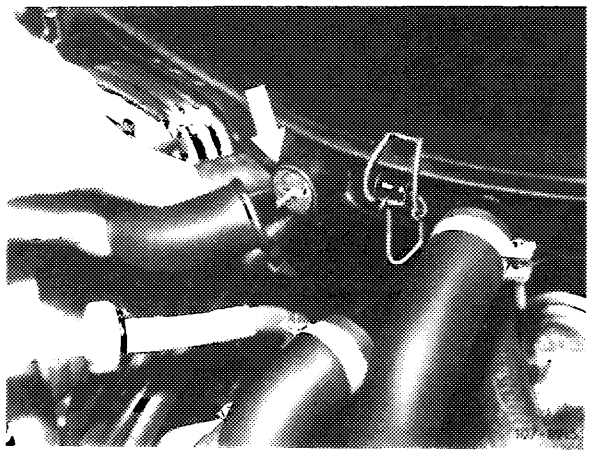
At idle speed and in low speed ranges the blow-by gas will enter into the combustion chambers via the vent jet and intake manifold or idle air passage.

In lower and medium speed ranges the intake manifold vacuum will cause fresh air to be drawn in from the air cleaner via a hose in addition to the blow-by gas.

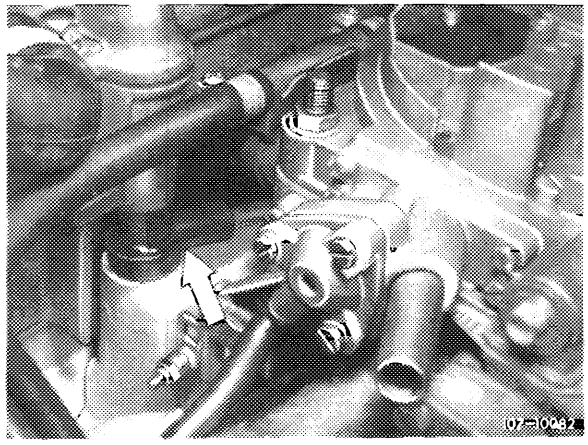
In the upper speed range blow-by gas will also flow from the fresh air side of the air cleaner depending on the blow-by quantity.

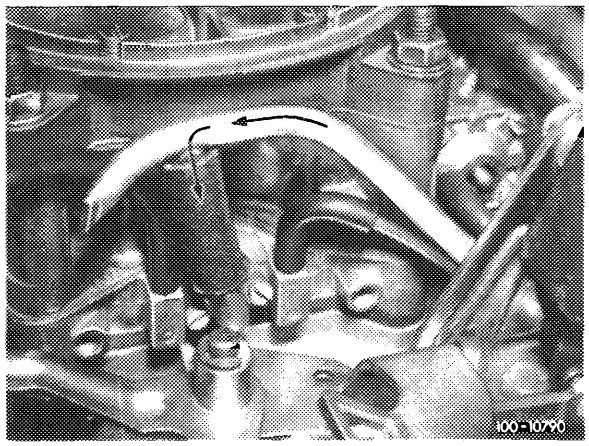
This is drawn off to the combustion chambers via the carburetor or air flow sensor and intake manifold.

Models for USA, Australia and Japan up to model year of 1977 have a flame guard (arrow) in the engine vent connection.

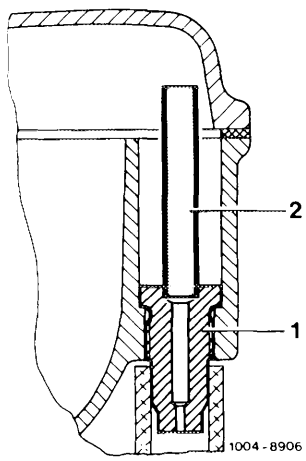


For 1975 and 1976 USA models, 1976 Sweden model and 1976 Japan models the blow-by gas is drawn off to the carburetor via an angle connector (arrow).





On USA vehicles starting model year 1980 the vent nozzle is mounted with an overflow pipe (2), so that no engine oil is carried along in idle speed air duct.



**Data**

| Group number[1] | | 0 | 1 | 2 |
|---|---|---|---|---|
| Standard dimension 86.0 | piston dia. | 85.970–85.982 | 85.980–85.992 | 85.990–86.002 |
| | cylinder dia. | 85.998–86.008 | 86.008–86.018 | 86.019–86.028 |
| Repair stage 1 + 0.5 | piston dia. | 86.470–86.482 | 86.480–86.492 | 86.490–86.502 |
| | cylinder dia. | 86.498–86.508 | 86.508–86.518 | 86.519–86.528 |
| Repair stage 2 + 1.0 | piston dia. | 86.970–86.982 | 86.980–86.992 | 86.990–86.002 |
| | cylinder dia. | 86.998–86.008 | 87.008–87.018 | 87.019–87.028 |

[1]) Decisive for association is the smallest measured cylinder dia. and the largest measured piston dia.

| | | |
|---|---|---|
| Max. wear limit in driving or transverse direction of cylinder bores at upper reversing point of 1st piston ring | | 0,10 |
| Piston clearance | When new | 0,025–0,035 |
| | Wear limit | 0,08 |

**Machining tolerances**

| | | |
|---|---|---|
| Permissible deviation (radial distance) from cylinder shape | When new | 0,007 |
| | Wear limit | 0,025 |
| Permissible deviation from square with reference to cylinder height | | 0,05 |
| Mean height of roughness | | 0,002–0,004 |
| Permissible height of waviness | | 50 % of roughness |
| Chamfer of cylinder bores | | see fig. point 2 |

**Conventional tools**

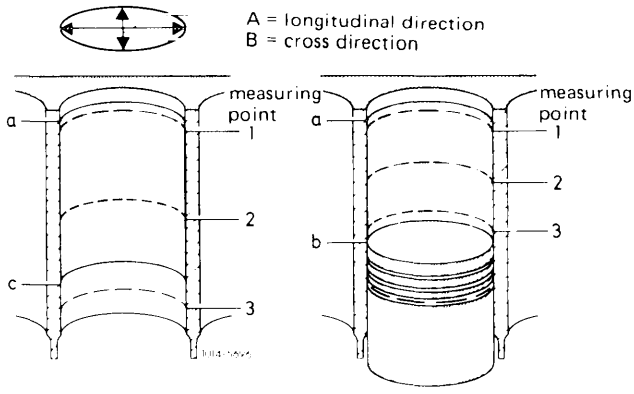
| | |
|---|---|
| Inside measuring instrument for 50–150 mm dia., with 0.01 mm readout and measuring point pressure relief | e.g. made by Hommel Handel, 5000 Köln 71 Sunnen GRM-2125 |

**Note**

In particular for a complaint concerning "excessive oil consumption" a measurement of the cylinder bores is essential in addition to a visual inspection.

1 Measure the cleaned cylinder bores with an internal tester at measuring points 1, 2 and 3 in longitudinal direction A (piston pin axis) and in cross direction B.

When the pistons are installed measuring point 3 will be just barely above the piston, which must be at BDC.




a top reversing point of first piston ring
b BDC of piston
c bottom reversing point of oil scraper ring

The group number punched into crankcase (arrow), matches the group number of the pistons installed as standard equipment.

On used engines, the original cylinder dia. shows up after thorough cleaning of top land zone.

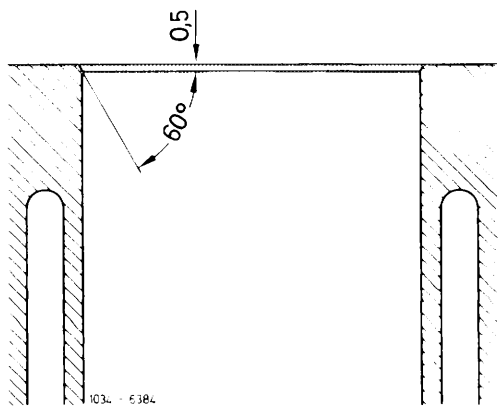
The difference in diameter of dimension shown on top land zone and the dimension at measuring point 1 generally indicates the respective max. wear.

In the event of repairs, hone cylinder bores according to dimensions of available pistons plus piston clearance.

The processing machines used for boring (pre-honing), finish-honing and polishing should be set in accordance with respective operating instructions.

Upon boring, the cylinder bores should be chamfered at upper cylinder end according to drawing.

The lower cylinder end should remain sharp edged without burr.



**Data**

| | |
|---|---|
| Height of new crankcase | 213.1—213.2 |
| Min. height after removal of necessary material | 212.8 |
| Permissible deviation from parallel of upper parting surface in relation to lower parting surface in longitudinal direction | 0,1 |
| Permissible deviation from flatness of upper parting surface | 0,03 |
| Mean height of roughness of upper parting surface | 0,005—0,020 |
| Leak test with 1.5 bar air gauge pressure under water. Permissible leak rate in cc/min | 10 |
| Chamfer of cylinder bores | see note |

**Piston spacing in relation to parting surface**

| Engines with | | normal compression | | USA version and low compression | |
|---|---|---|---|---|---|
| Distance between piston crown and crankcase mating surface | Standard size piston | Below | min. 0.20<br>max. 0.70 | above 0.25<br>below 0.15 | |
| | Oversizes<br>+ 0.5 and 1.0 | Below | min. 1.0<br>max. 1.5 | below | min. 0.55<br>max. 0.95 |

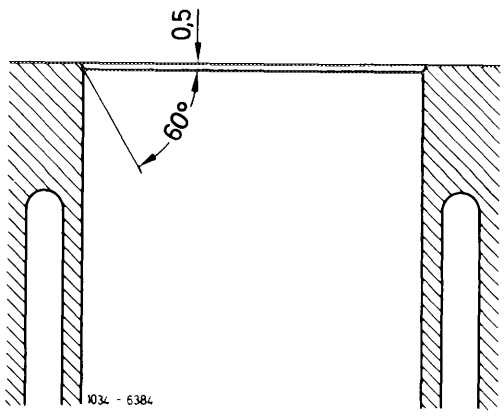
**Conventional tools**

| | |
|---|---|
| Surface grinding machine | e.g. made by Ruaro u. Fi., Schio/Italy<br>Scledum, type RTY |
| Knife-edge straightedge approx. 750 mm long | |

**Note**

Chamfer cylinder bores after grinding.

Adjust valve timing (05—215), if crankcase mating surface has been machined.

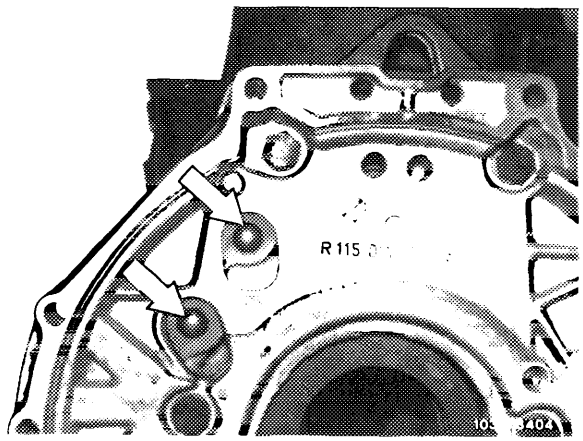


# 01–130 Knocking-out and inserting steel balls for main oil ducts

| Tightening torques | | Nm |
|---|---|---|
| Fastening bolts for intermediate flange | | 65 |
| Closing plug for main oil duct | | 40 |
| Pressure relief valve in main oil duct front | | 40 |
| Closing plug pressure relief valve | | 50 |
| Screw M 8 x 65 for vibration damper | | 35 |
| Screw M 18 x 1.5 x 45 on crankshaft | | 400–450 |
| Necked-down screw for driven plate and flywheel | initial torque | 40 |
| | torque angle | 90°–100° |

**Note**

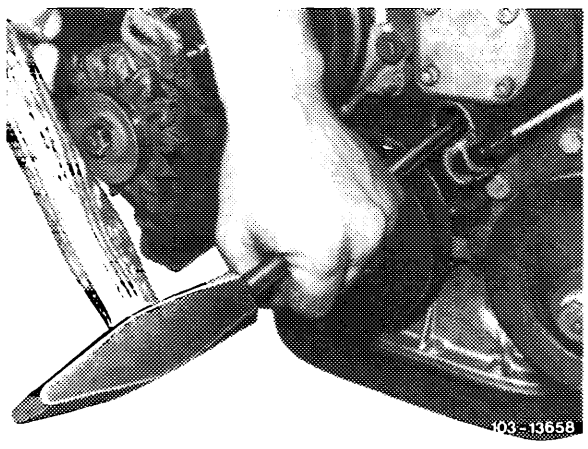
Since October 1976 the 2 main oil ducts (arrows) in cylinder crankcase at transmission end are closed by means of steel balls 15 mm dia. VO DIN 5401 part no. 005401 515001.




For cleaning main oil ducts during engine repairs, the steel balls must be knocked-out from direction of front end of engine.

Undamaged steel balls can be used several times without refinishing ball seat in crankcase.

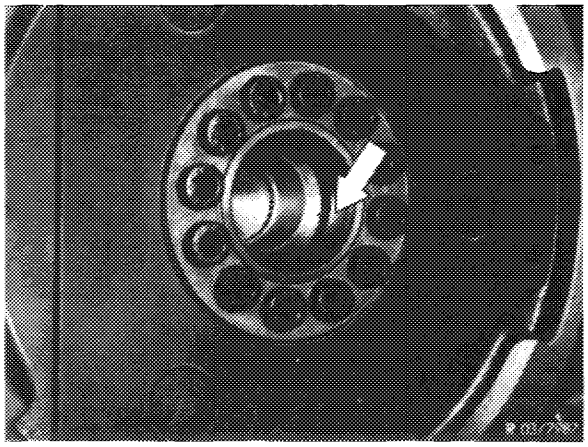
Damaged and rusty steel balls should be replaced.



**Knocking-out steel ball in upper main oil duct**

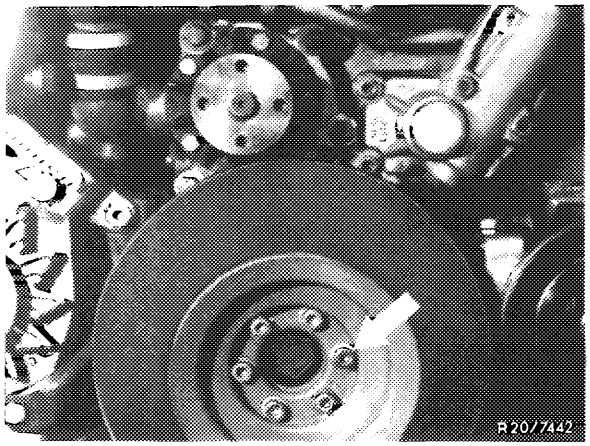
1 Remove transmission.

2 Remove flywheel (03–410).



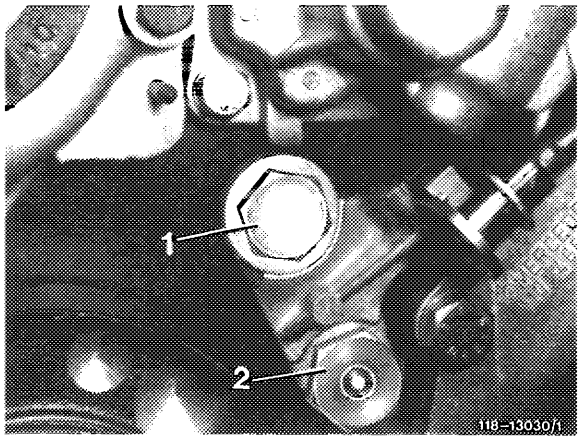
3 Remove radiator (20–420).

4 Remove vibration damper (03–340).




5 Unscrew closing plug (1) and screw oil pressure relief valve out of main oil duct.

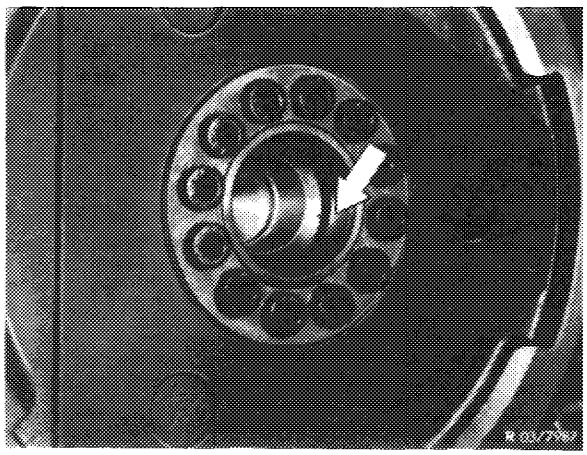
6 Knock-out steel ball from direction of engine front end by means of a round steel bar 13 mm dia. and approx. 700 mm long.




**Knocking-out steel ball in lower main oil duct**

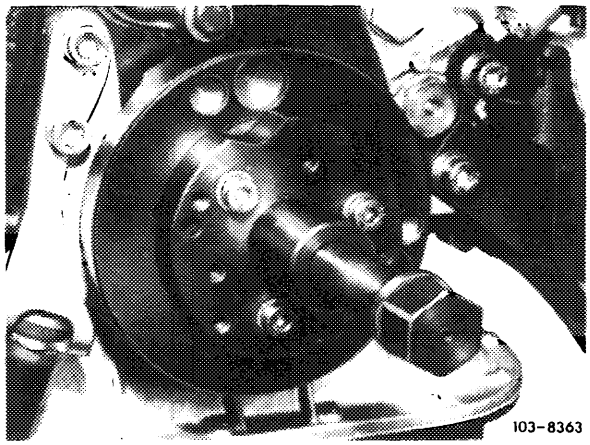
1 Remove transmission.

2 Remove flywheel (03–410).



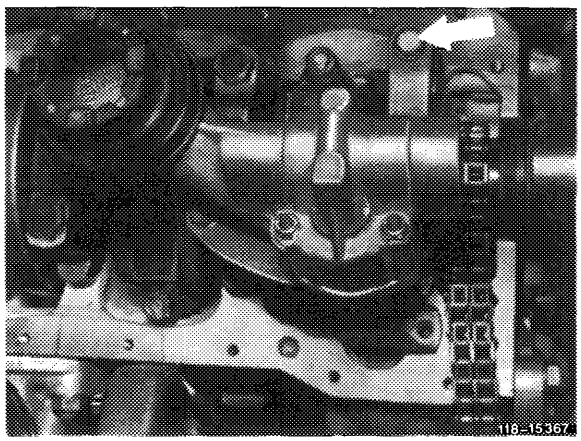
3 Remove radiator (20–420).

4 Remove vibration damper and compensating weight (03–340).



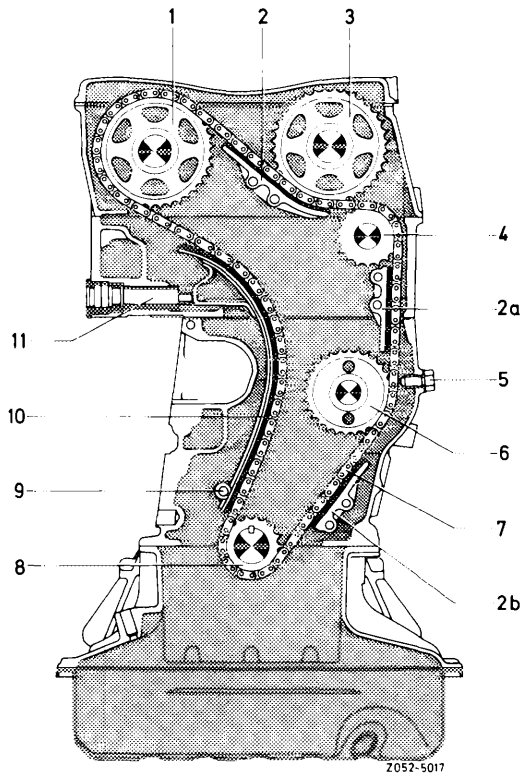

5 Remove complete oil pan (01–310).

6 Remove oil pump (18–210).




7 Remove slide rail (2b) in crankcase (05–340).

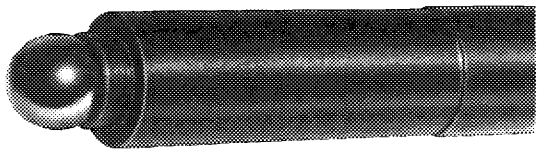
8 Knock-out steel ball from direction of engine front end by means of a round steel bar 13 mm dia. and approx. 700 mm long.



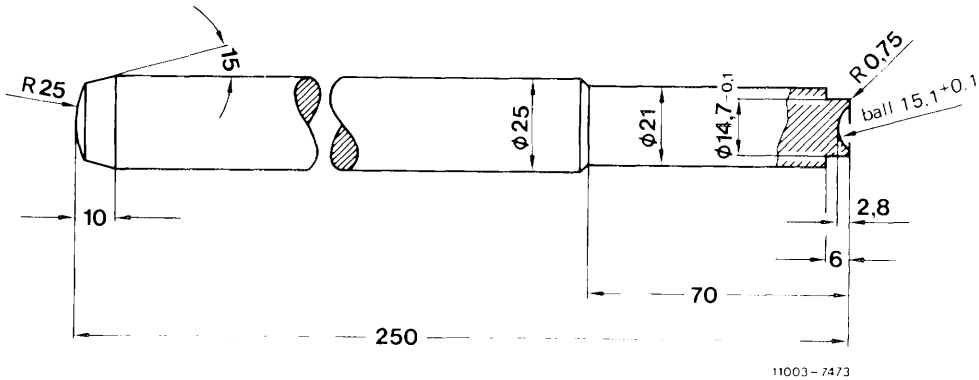
## Closing main oil duct

1 Thoroughly clean ball seat and bore in main oil duct.

2 Coat up on self-made knocking-in mandrel with grease and place steel ball into cup.



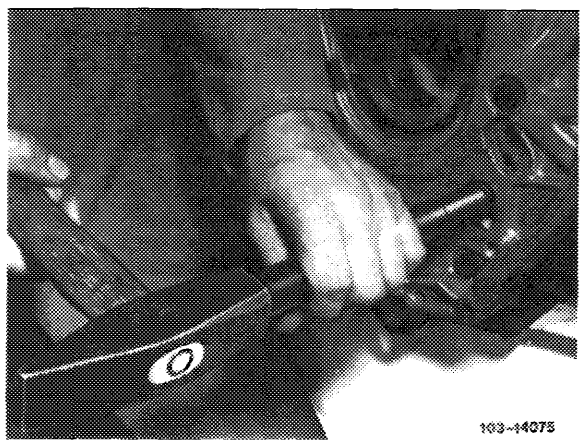
103-13405




11003-7473

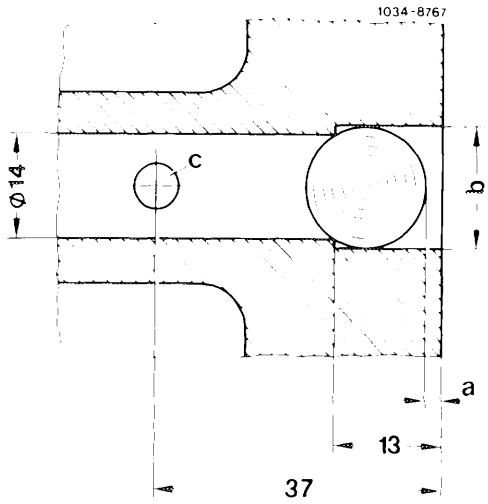
Material: C 45

3 Position steel ball with knocking-in mandrel and knock-in up to stop on mandrel.



103-14075

If the mandrel has no stop, do not exceed dimension a = max. 3 mm to prevent cracking of crankcase.




a = max. 3 mm
b = dia. 14.75 to 14.86 mm
c = oil ducts to crankshaft bearing

4 Mount all parts taken off or removed.

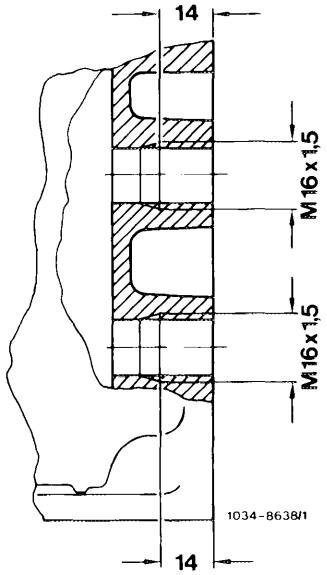
5 Run engine warm and check for leaks.

**Note:** If oil flows out as the result of a leaking ball seat, knock-out respective steel ball and close main oil duct with a closing plug after cutting the required threads into duct.

**Closing main oil duct with closing plug**

1 Cut threads M 16 x 1.5 mm approx. 14 mm deep into respective main oil duct.

2 Carefully clean main oil duct.




3 Screw closing plug M 16 x 1.5 mm DIN 908, part no. 000 908 016 001 with aluminum sealing ring A 16 x 22 mm DIN 7603 – AL, part no. 007 603 016 102, and tighten to 40 Nm.

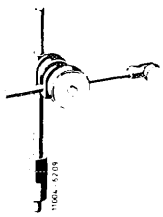
# 01–220 Installation and centering of intermediate flange

## Data

| | | |
|---|---|---|
| Radial runout of intermediate flange | | max. 0.10 |
| Permissible axial runout of intermediate flange when mounted in crankshaft bearing basic bore during one full turn. | | 0.10 |

| Tightening torques | | Nm |
|---|---|---|
| Intermediate flange mounting bolts | | 65 |
| Drive plate and flywheel expansion bolt | Torque pressure | 40 |
| | Torque angle | 90–100° |

## Special tool

| | | |
|---|---|---|
| Dial gage holder (two required) |  | 121 589 00 21 00 |

## Self-made tool

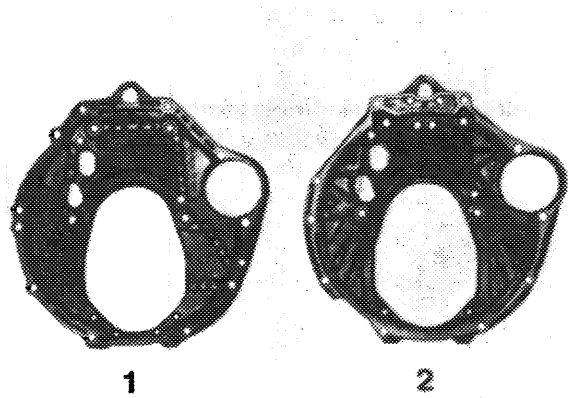
| | |
|---|---|
| Threaded pin | see fig, point 3 |

## Conventional tool

| | |
|---|---|
| Dial gauge A 1 DIN 878 | e.g. made by Mahr, 7300 Esslingen order no. 810 |

## Note

A replaced intermediate flange must be centered. The automatic transmission W4A040 requires the intermediate flange (1) with fitted pin and all-around centering system, which can be used as a replacement for the formerly used intermediate flange (2) with all-around centering system.



1 2

1 Modified intermediate flange 110 011 15 45
2 Former intermediate flange 115 011 11 45

Series installation of intermediate flange
110 011 15 45 starting end of november 1979

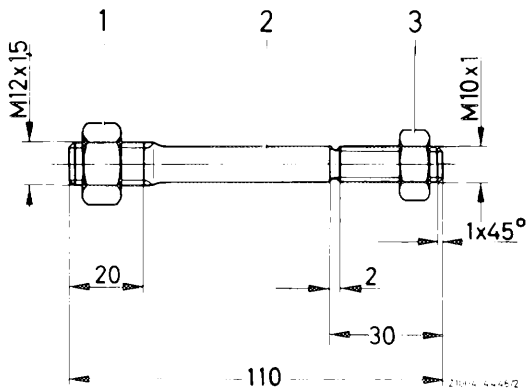
| | Starting engine end no. | Starting chassis end no. |
|---|---|---|
| 110.923 | –10–014 453 | 123.030–028 448 |
| | –12–017 710 | 123.050–003 543 |
| 110.984 | –10–021 092 | 123.033–067 904 |
| | –12–070 620 | 123.053–018 127 |
| 110.922 | –10–040 775 | |
| | –12–067 894 | 116.020–121 410 |
| 110.932 | –10–010 365 | |
| | –12–002 796 | |
| 110.985 | –10–014 287 | 116.024/025–154 967 |
| | –12–073 060 | |
| 110.986 | –10–003 392 | 107.042–007 301 |
| | –12–007 701 | 107.022–007 921 |

**Installing and centering**

1 Place intermediate flange over dowel pins in crankcase.

2 Tighten the four mounting bolts slightly.

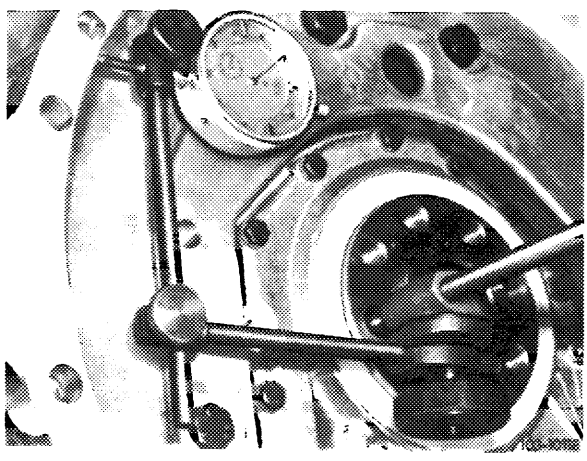
3 Screw threaded bolt (self-made) into crankshaft and counterlock with hex nut.




1 Hex nut M 12 x 1.5
2 Threaded bolt 10 mm dia
3 Hex nut M 10 x 1

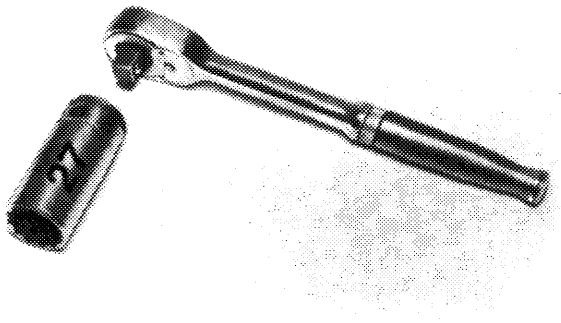
4 Attach dial gauge holder with dial gauge to threaded bolt.

5 Position feeler pin at fitting point of centering surface. Set dial gauge to 0.



6 Rotate crankshaft for one full turn by means of tool combination. Vertical runout should not exceed max 0.10 mm.

**Note:** When rotating crankshaft, make sure that the feeler pin of the dial gauge is not getting stuck.



1100-6498/1

7 Correct vertical runout by light blows against intermediate flange.

8 Tighten fastening screws.

**Note:** If the vertical runout exceeds 0.10 mm, remove intermediate flange.

9 Increase diameter of both fitted bores in intermediate flange to 12.1 mm.

10 Repeat item 1–8.

# 01–310 Complete removal and installation of oil pan

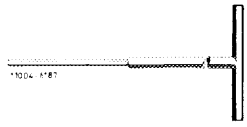
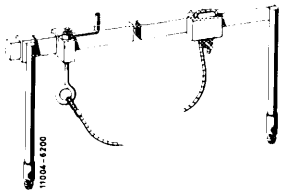
**Oil capacity in liters**

| | | | |
|---|---|---|---|
| Oil dipstick color code | | wine red, pink brown[1] ) | yellow-green |
| Oil pan | | 6 | 5.5 |
| Oil filter | | 0.5 | |
| Air oil cooler | Model 107, 114, 116 | 0.7 | |
| | Model 123, 126 | 0.40 | |

1) (USA) model year 1975/76

| **Tightening torques** | Nm |
|---|---|
| Oil drain plug on oil pan | 40 |
| Oil drain plug on air oil cooler | 35 |
| Filter lower section mounting bolt | 45 |
| Oil pan lower section to upper section | 11 |

**Special tools**

| | | |
|---|---|---|
| Stud/ring wrench 13 x 14 mm | | 117 589 02 07 00 |
| Stud wrench 5 mm, 300 mm long |  | 116 589 02 07 00 |
| Stud wrench 6 mm, 440 mm long | | 116 589 03 07 00 |
| Engine support |  | 107 589 02 61 00 |
| Knocking-in tool for oil dipstick guide tube | | 117 589 00 31 00 |
| Knocking-out mandrel 9 mm dia | | 110 589 02 15 00 |

**Conventional tool**

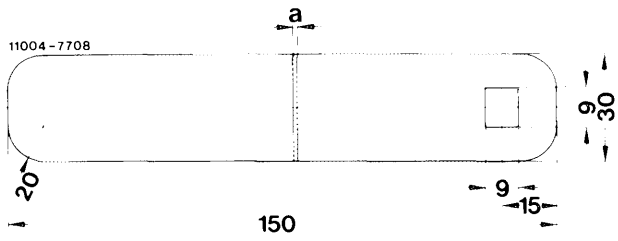
| | |
|---|---|
| Engine hoist (Motordirigent) size 1.5 | e.g. made by Bäcker, D-5630 Remscheid, order no. 3178 |

**Self-made tools**

Gauges for cutting-off radial sealing rings

Radial sealing ring graphite-grey
Part no. 000 997 65 41 a = 1 mm

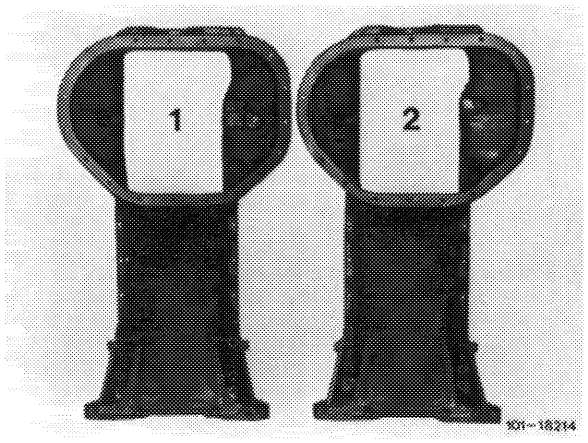
Radial sealing ring yellow-brown a = 0.5 mm




**Note**

The modified oil pan (1) is installed on models 107, 116 and 123 since October 1979 and model 126 since begin of series.

For this purpose, the rear 3 fastening threads on cylinder crankcase have been changed on both sides from M 6 to M 8 mm.

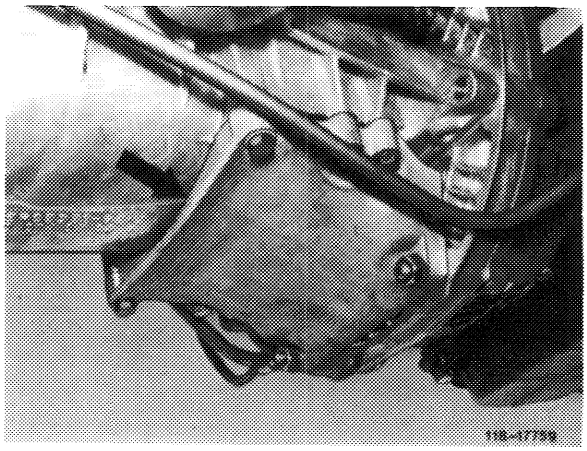



**Begin of series: October 1979**

| Model | Engine | Engine end no. manual transm. | automatic transm. | chassis end no. |
|---|---|---|---|---|
| 107.022 | | | | 007709 |
| 107.042 | 110.986 | 003225 | 007317 | 006965 |
| 116.020 | 110.922 | 040571 | 067591 | 120830 |
| 116.020 | 110.932 | 010337 | 002781 | |
| 116.024/025 | 110.985 | 014120 | 070947 | 152618 |
| 123.030 | 110.923 | 014163 | 017466 | 028051 |
| 123.033 | 110.984 | 020182 | 068009 | 065415 |
| 123.050 | 110.923 | 014163 | 017466 | 003470 |
| 123.053 | 110.984 | 020182 | 068009 | 017451 |
| 123.093 | | | | 004597 |

This modified oil pan is screwed to cylinder crankcase at the rear with 6 screws M 8 x 95 mm, formerly 4 screws M 6 x 40 mm and 2 screws M 6 x 25 mm.

On model 126 the modified oil pan is screwed to cylinder crankcase together with supporting tray (arrow) by means of 6 screws M 8 x 110 mm.



If a modified oil pan is installed in the course of repairs, the respective threaded bores in cylinder crankcase should be enlarged from M 6 to M 8 mm.

In the event of repairs, use radial sealing ring 000 997 90 41 (yellow-brown) with a projection of 0.5 mm on both sides, except when a new or newly ground crankshaft with new crankshaft bearings is installed. In such a case, use radial sealing ring 000 997 69 41 (graphite-grey) with a projection of 1 mm on both sides. This will protect the rear bearing journal of crankshaft against being overheated under influence of a low crankshaft bearing play and excessive pressure against yellow-brown radial sealing ring.

## Removal

### Model 107

1 Remove front axle (33–100).

2 Detach oil return pipe at cylinder head and pull off at oil pan.

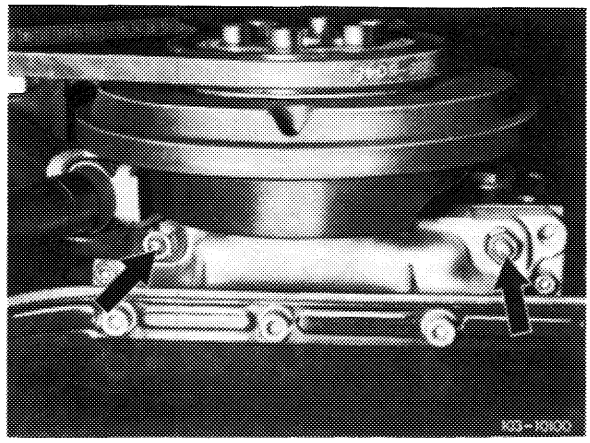
3 Detach oil dipstick guide tube at cylinder head.

4 Detach steering rod at one side.

5 Detach alternator holder strut at oil pan.

6 Remove oil pan downward.

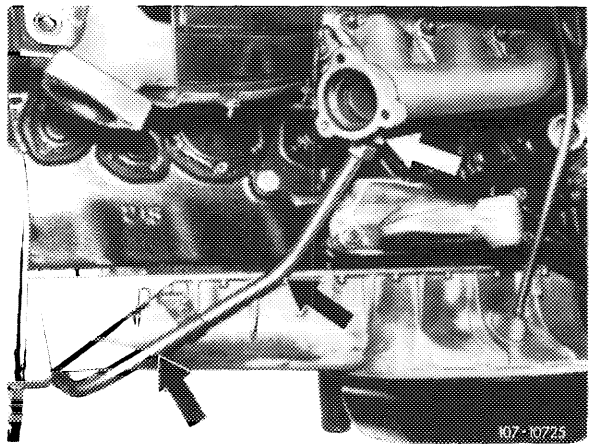
**Note:** Hold engine with engine support when working underneath engine.



**Model 114**

1 Remove front axle (33–100).

2 Remove exhaust gas recirculation line (arrows) for USA models.



3 Remove oil lines for automatic transmission.

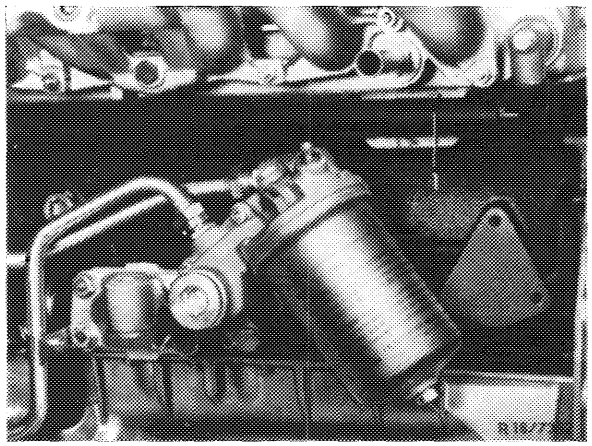
4 Detach oil dipstick guide tube at cylinder head.

5 Pull oil return line (1) off of oil pan (18–030).

6 Drain engine oil.

7 Remove oil pan.

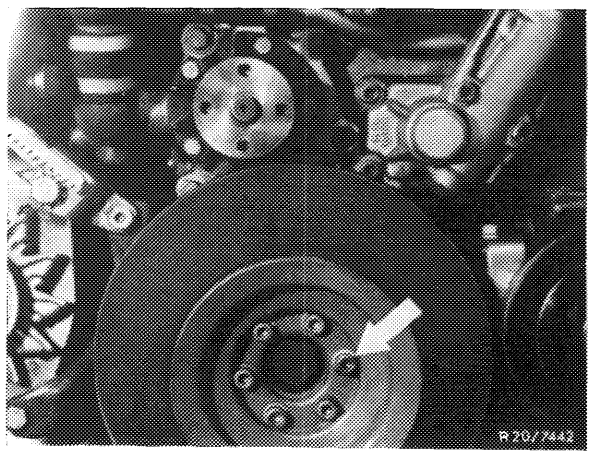
**Note:** Hold engine with engine support while working underneath engine.



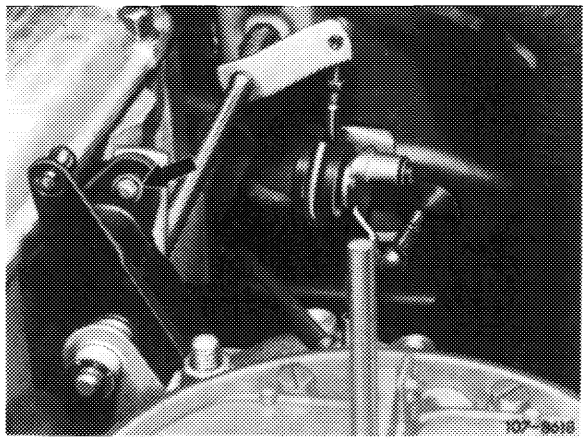
**Model 116**

1 Remove radiator.

2 Remove vibration damper (03–340).



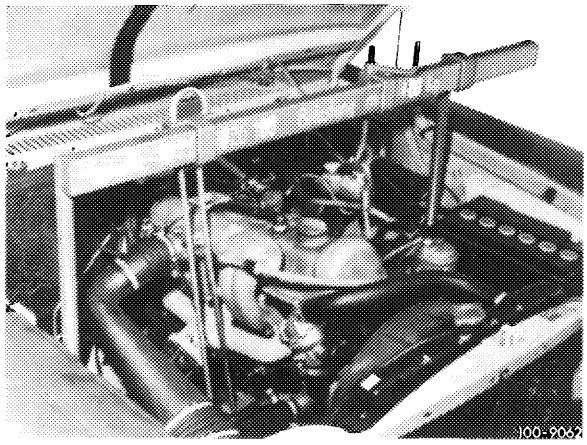
3 Detach control shaft (07.2–442).



4 Detach both front engine mounts and engine dampers.

5 Pull oil return line off of oil pan (18–030).

6 Drain engine oil.

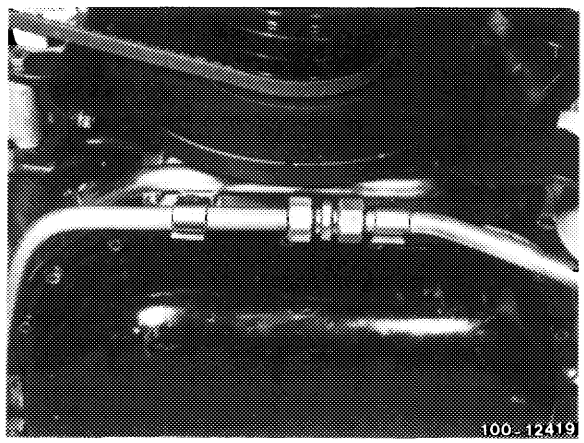


7 Remove oil pan lower section and oil pump. Remove fuel pump of carburetor engines.

8 Remove oil lines for automatic transmission.

9 Detach oil dipstick guide tube at cylinder head and drive it out from below with a 7.5 mm dia. mandrel.

Knock-out oil guide tube for drawing off oil with knocking-out mandrel 9 mm.



USA version

10 Detach rear engine mount, lift engine and place an approximately 40 mm thick piece of wood underneath.

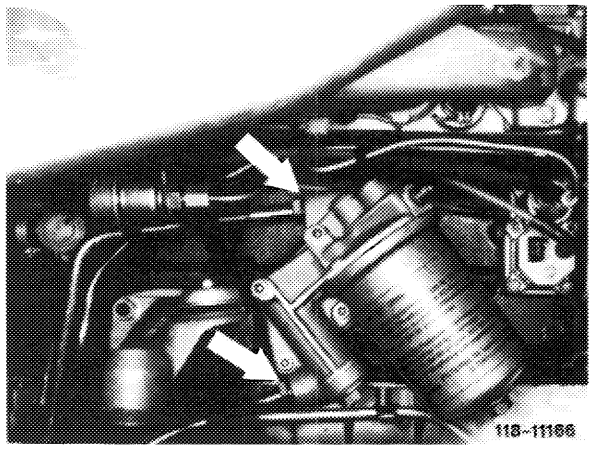
11 Lift front of engine and place approximately 60 mm thick pieces of wood on both sides between the engine carrier and engine mounts.

12 Detach oil pan and remove forward.

**Model 123**

1 Remove engine (01–030).

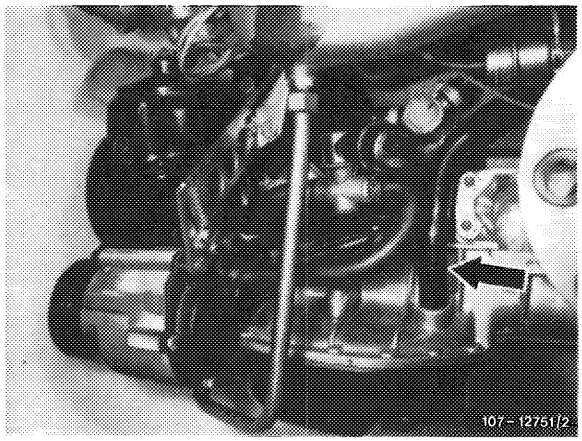
2 Remove oil filter complete with lines.




3 Pull-off oil return pipe (arrow).

4 Loosen strut for alternator bracket on oil pan.

5 Remove oil pan.




USA version

**Model 126**

1 Pull-off oil return line on oil pan.

2 Remove supporting tray.

3 Turn wheels completely to the left.

4 Unscrew cover plate.

5 Remove vibration damper (03–340).

6 Unscrew lower holding bracket of alternator.

7 Unscrew oil pan upper half to the extent that it is still held to crankcase by 2 screws.

8 Remove oil pan lower half.

9 Remove oil pump (3 screws).

10 Pull oil dipstick guide tube at top out of holder and knock out of oil pan upper half from below by means of a plastic hammer.

11 On vehicles with refrigerant compressor, remove lower strut.

12 Disconnect regulating linkage.

13 Unflange propeller shaft at transmission and push back.

14 Unscrew engine shock absorber below.

15 Unscrew screws for engine carrier on engine mount.

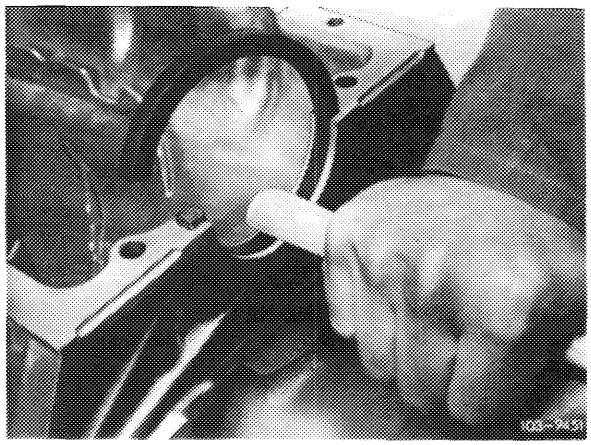
16 Suspend engine at the front and rear on engine removing eyes and lift until oil pan can be removed.

**Installation, all models**

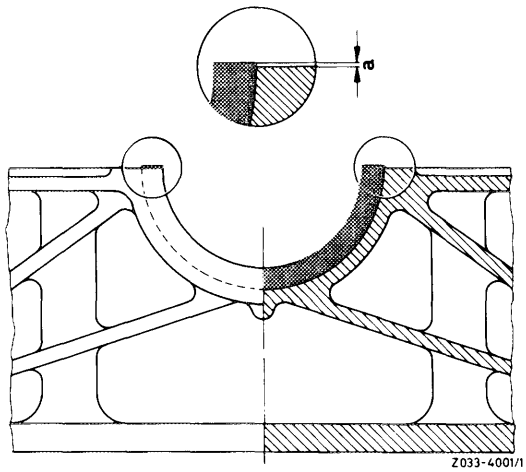
1 Clean parting surface on cylinder crankcase and oil pan.

2 Renew rear radial sealing ring in oil pan and work in.

**Note:** Do not install radial sealing ring 000 997 90 41 (yellow-brown) in engines which are provided with a new or refinished crankshaft and new crankshaft bearings in the event of repairs.



3 To arrive at an overlap, cut off radial sealing ring approx. 0.5 or 1.0 mm above parting surface. Use self-made gauge for this purpose.




| Radial sealing ring, part no. | Dimension a (mm) |
|---|---|
| 000 997 69 41 (graphite-grey) | 1.0 |
| 000 997 90 41 (yellow-brown) | 0.5 |

4 Provide radial sealing ring with engine oil.

5 Coat parting surface of oil pan with sealing compound.

6 Install oil pan and screw-on lightly at front and rear with 2 screws each.

**Attention!**
The oil pan should rest against or be screwed to intermediate flange prior to tightening fastening screws for crankcase.

7 For further installation proceed vice versa.

**Attention!**
Check regulating linkage for function.

| Timing at 2 mm valve lift | | Engine 110 | Engine 110 California 1974 | Engine 110 Federal 1973 and 1974 |
|---|---|---|---|---|
| Camshaft code number[1]) | Exhaust | 24, 57, 71, 78 | 24 | 30, 95 |
| | Intake | 25, 67, 74 | 25, 74 | 33, 91 |
| Intake valve | opens after TDC | 7° | | 11° |
| | closes after BDC | 21° | | 15° |
| Exhaust valve | opens before BDC | 30° | | 22° |
| | closes before TDC | | | |

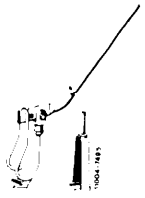
[1]) The camshaft code number is punched into rear end of camshaft.

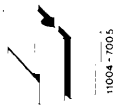
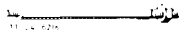
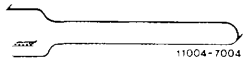
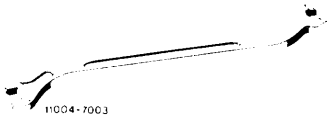
| Valve clearance | on cold engine (approx. 20 °C) | on warm engine (60°C ± 15°C) |
|---|---|---|
| Intake | 0.10[1]) | 0.15[1]) |
| Exhaust | 0.25 | 0.30 |

[1]) 0.05 mm larger during lasting outside temperatures below –20°C.

| Tightening torques | | Nm |
|---|---|---|
| Bolts and cap nuts for cylinder head cover | | 5 |
| Necked-down screw for camshaft sprockets | | 80 |
| Cylinder head bolts M 12 x 1.5 on cold engine | step 1 | 40 |
| | step 2 | 70 |
| | after 10 min. setting time | 110 |
| Bolts M 8 for cylinder head to crankcase | | 25 |
| Closing plug chain tensioner | | 50 |
| Threaded ring chain tensioner | | 50 |
| Ball seat ring in chain tensioner | | 25 |

**Special tools**

| | | |
|---|---|---|
| Remover and installer for rocker arm |  | 110 589 04 61 00 |

| | | |
|---|---|---|
| Rigid chain tensioner | | 110 589 03 31 00 |
| Chain tensioner holder |   | 110 589 02 31 00 |
| Bearing pin impact extractor (basic unit) | | 116 589 20 33 00 |
| M 6 x 50 bolt for impact extractor | | 116 589 01 34 00 |
| M 6 x 150 bolt for impact extractor |  | 116 589 02 34 00 |
| M 10 x 100 bolt for impact extractor | | 116 589 03 34 00 |
| Camshaft wrench |   | 116 589 01 01 00 |
| 17 mm valve adjusting wrench |   | 110 589 01 01 00 |
| 27 mm socket to turn engine, 1/2" square | | 001 589 65 09 00 |
| Socket 10 mm 1/2" square 140 mm long | | 000 589 05 07 00 |

**Conventional tools**

| | |
|---|---|
| Engine director size 1.5 | e.g. made by Bäcker, D-5630 Remscheid<br>Order No. 3178 |

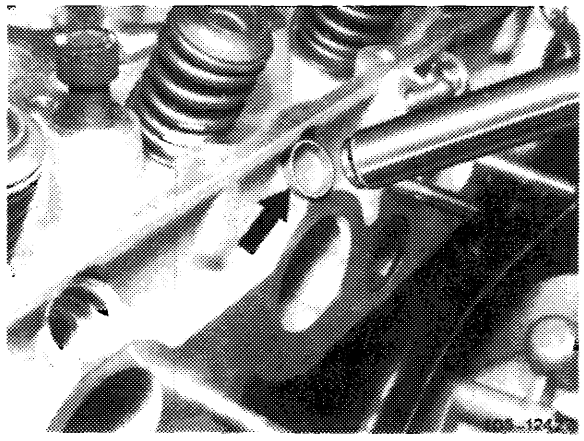
**Note**

A cylinder head may only be removed after the engine is cold. Removal is together with the camshaft housing, exhaust manifold and intake manifold.

There is only one type of cylinder head as a replacement part for carburetor and fuel injection engines.

If the cylinder head is used on a carburetor engine, the fuel injector bores must be plugged with 6 covers, part number 000 443 01 80 00.

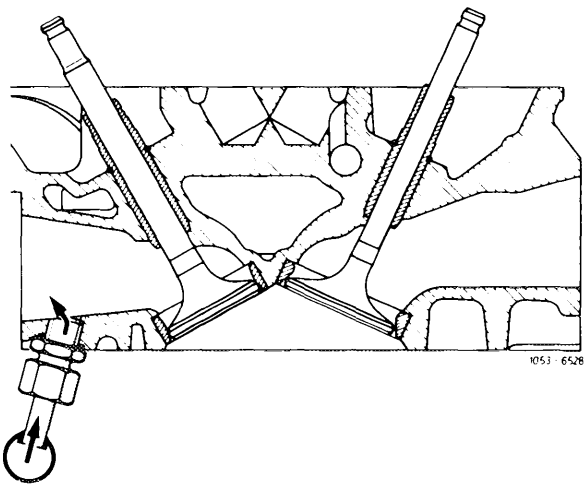
Starting April 1978 exhaust valve seat rings 42 mm OD and valve guides 9 mm ID are installed in cylinder head. Exception: engines national version.



Cylinder heads for engines with air injection are attached to exhaust ducts by means of threaded bores for air injection.

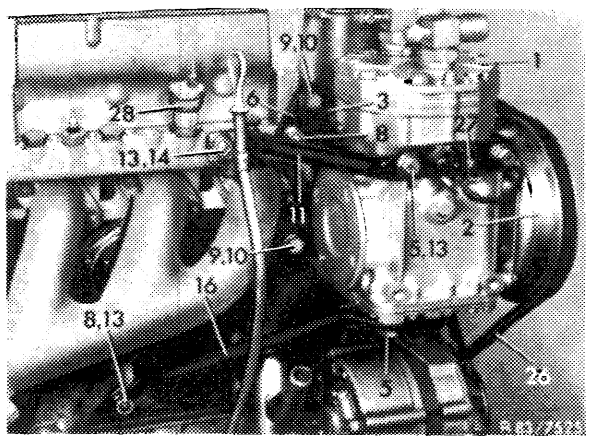
The diameter of the combustion chamber frame on cylinder head gaskets for the various repair stages varies:

| Cylinder bore | Combustion chamber frame |
|---|---|
| 86.00 ϕ<br>86.50 ϕ | 86.70 + 0.5 mm ϕ |
| 87.00 ϕ | 87.20 + 0.5 mm ϕ |

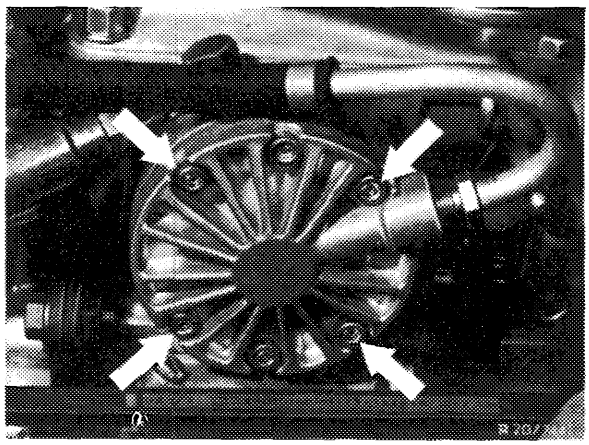


**Removal**

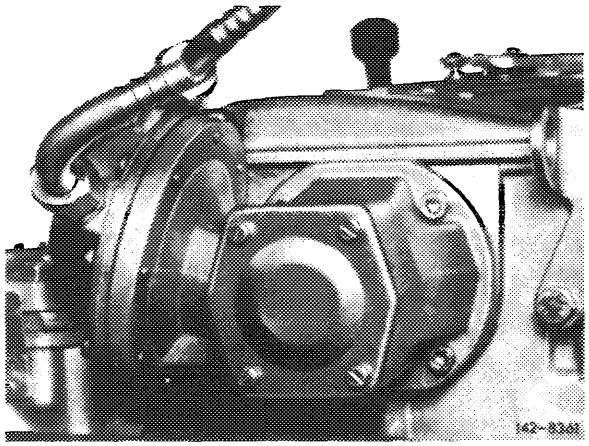
1 Remove compressor of models with an air conditioner.



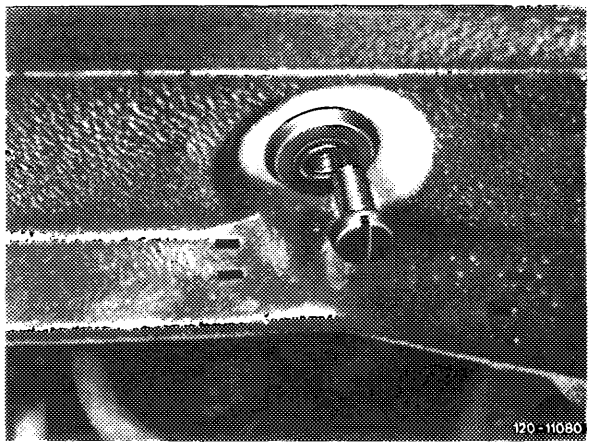

2 Remove oil pump of models with a level control system and place it to one side without undoing the lines. Only unscrew the bolts marked with an arrow for this purpose.



3 Remove vacuum pump of models for USA.

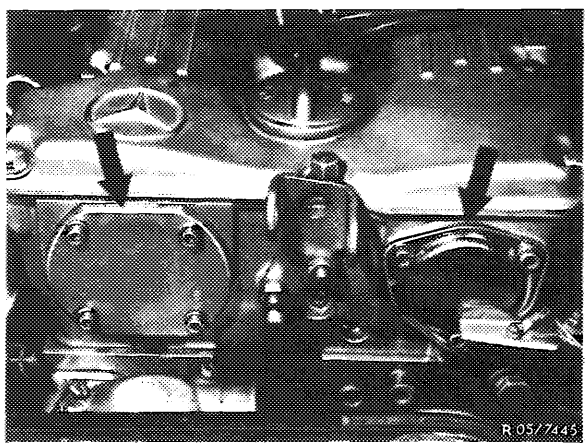


4 Drain coolant from radiator and engine.



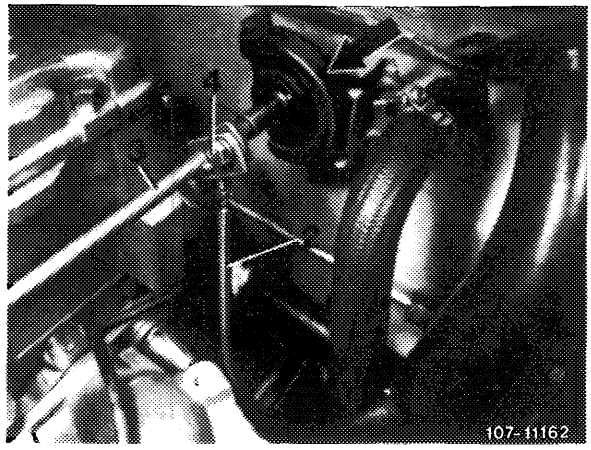
Model 123

5 Unscrew both covers at front of camshaft housing.

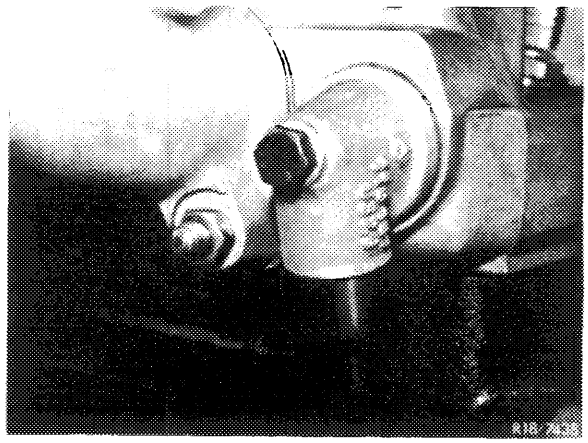


6 Disconnect all electric wires, heater water, fuel and vacuum lines which are connected to the cylinder head and intake manifold or carburetor.

7 Remove longitudinal regulating shaft (3).

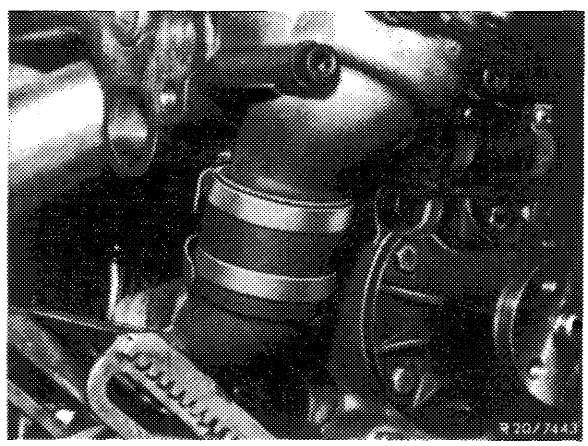



8 Disconnect oil return pipe at cylinder head.



9 Remove hose between thermostat housing and water pump.

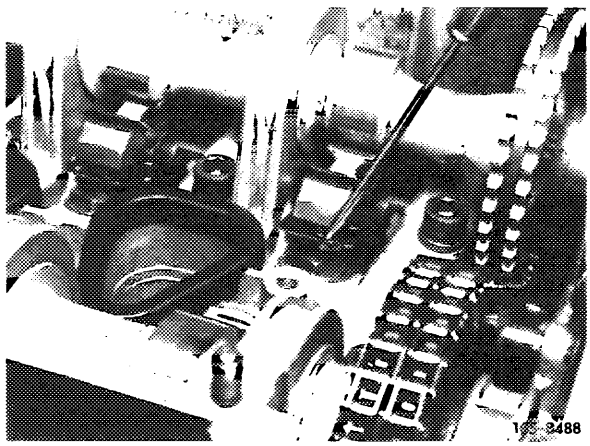
Disconnect bypass line at water pump.



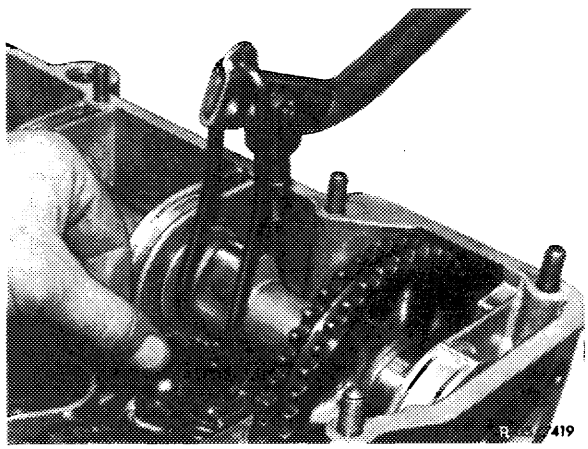
10 Disconnect oil dipstick guide tube from clamp on cylinder head and bend to one side.

11 Detach exhaust pipe at exhaust manifold and transmission. Unscrew pre-heating cowl of models with carburetor engines.

12 Press out all spring clamps with a wrench socket.

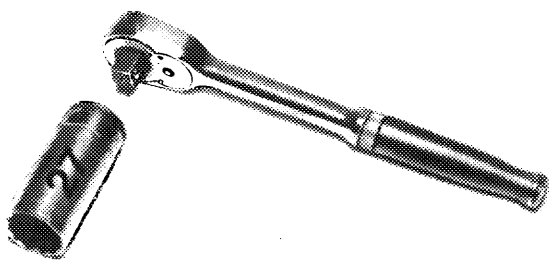


13 Remove all rocker arms with the remover and installer (05–230).



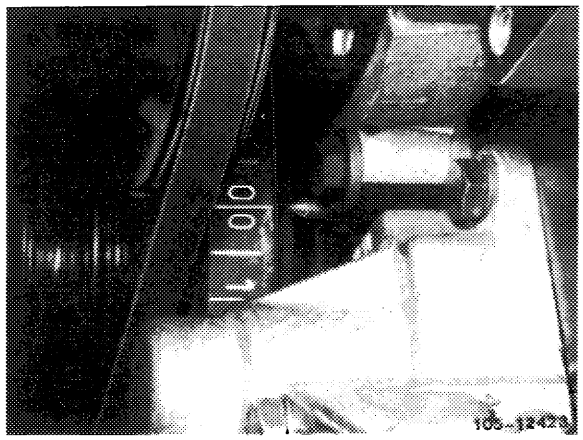
14 Turn crankshaft with combination tool.

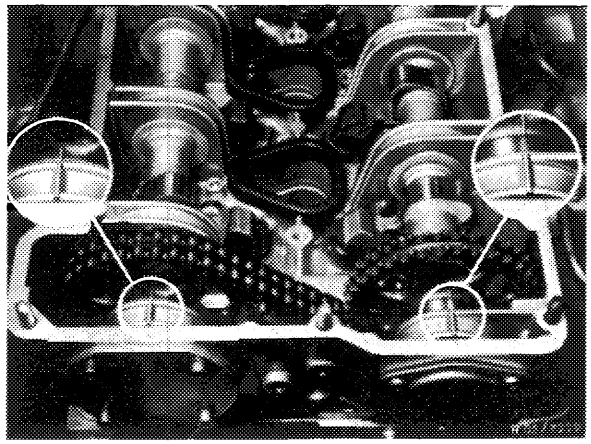
**Attention!**
**Don't** turn engine on **camshafts.** Don't turn engine in reverse direction of rotation.



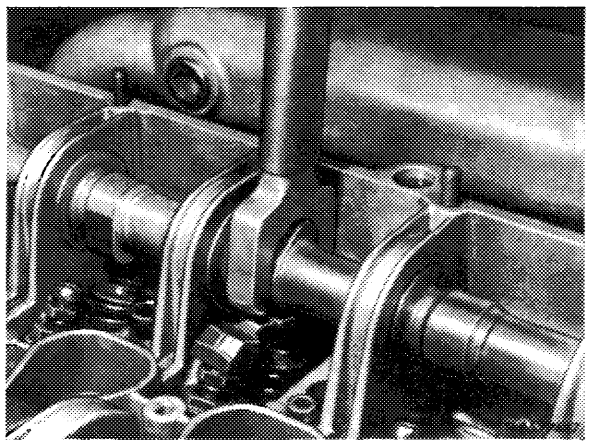
1100-6498/1

15 Position 1st cylinder of engine at ignition TDC. Marks on camshaft sprockets and camshaft housing must align.



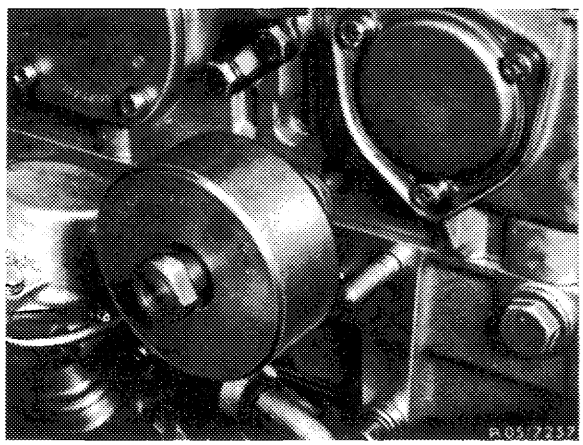


16 Remove both expansion bolts of camshaft sprockets. Counterhold camshaft with holder.



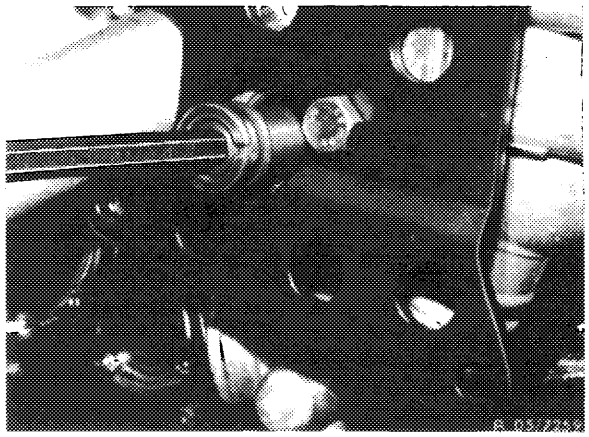
17 Remove upper slide rail in camshaft housing (05–340).

Knock out bearing pins with the impact extractor for this purpose.

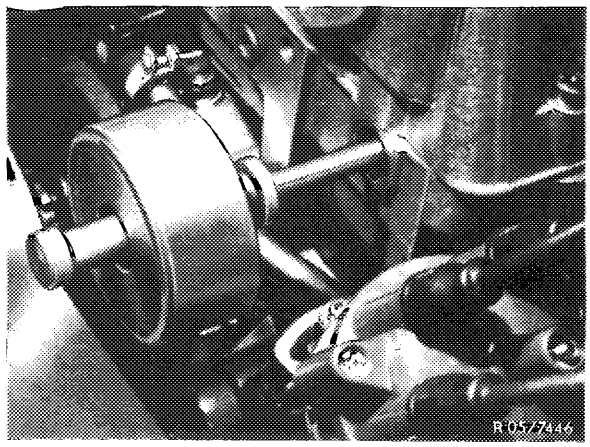


18 Remove chain tensioner (05–310).

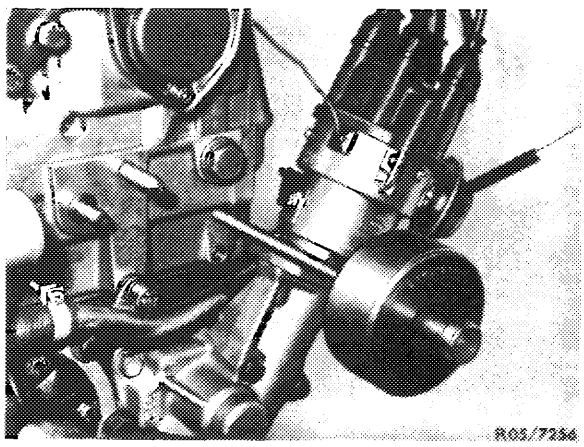
19 Push both camshafts to the rear and remove camshaft sprockets.



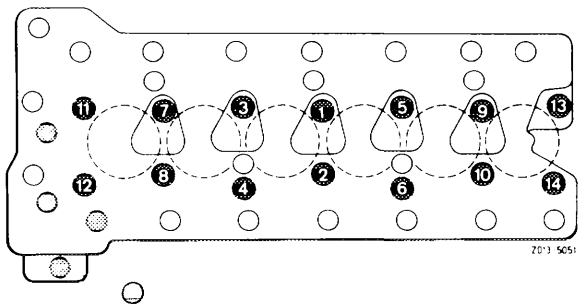
20 Remove guide wheel. Knock out bearing pins with impact extractor (M 10 bolts) for this purpose.



21 Remove guide rail in cylinder head. Knock out bearing pins with impact extractor (6 x 150 mm bolt) for this purpose.



22 Loosen and remove cylinder head bolts in reverse sequence of tightening diagram. Pull out the two **M 8 bolts in the timing case** with a magnet.



23 Pull up timing chain and press tensioning rail to center of engine. Lift off cylinder head straight up with a cable attached to the suspension eyes.

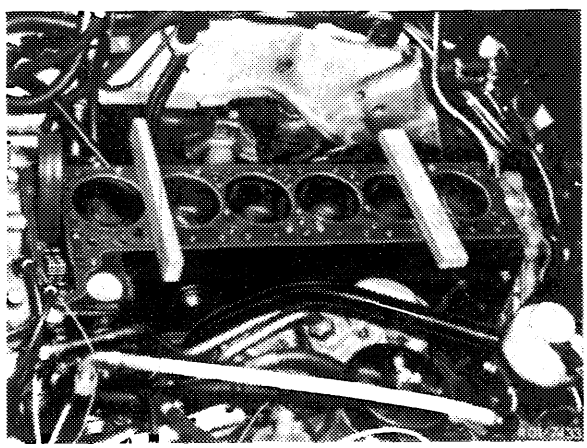
**Installation**

24 Clean cylinder head and crankcase mating surfaces thoroughly.

25 Install new cylinder head gasket.

**Note:** Two dowel sleeves are press-fit in the crankcase to locate the cylinder head.

26 Place two locally manufactured wooden boards (15 x 35 x 240 mm) on the cylinder head gasket, front upright and rear flat.



27 Place cylinder head on board, guide in timing chain and tensioning rail.

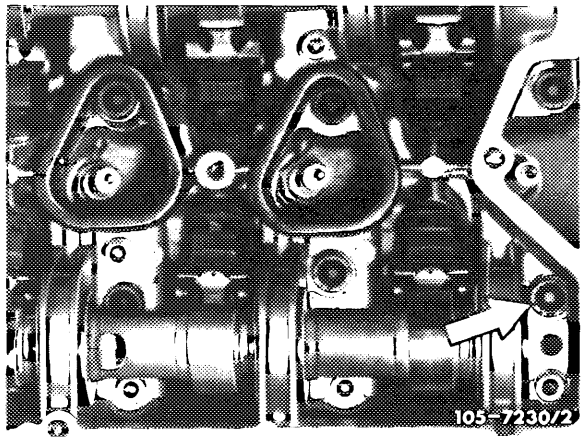
28 Lift front of cylinder head and pull out front wooden board toward exhaust side. Lower cylinder head until it fits on the dowel sleeve.

29 Lift rear of cylinder head slightly and pull out wooden board toward exhaust side. Lower cylinder head until it fits over rear dowel sleeve.

**Note:** If possible, connect cylinder head with camshaft housing to eyes for engine removal, carefully lower with a crane and set down.

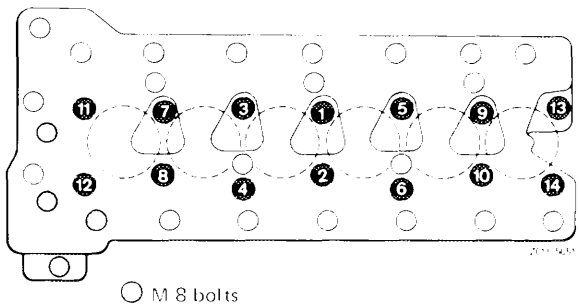
30 Lubricate threads and head surface of cylinder head bolts before installation.

**Attention!**
Since July of 1974 the clearance on the camshaft housing for the **22 mm dia. washer** of cylinder head bolt number 14 has been extended. The former **20 mm dia. washer** must be installed on older camshaft housings (arrow).




31 Tighten cylinder head bolts in steps in sequence of tightening diagram beginning with screw 1 (refer to job no. 01–415 removal and installation of cylinder head).

Tighten screws M 8 to 25 Nm (2.5 kpm).



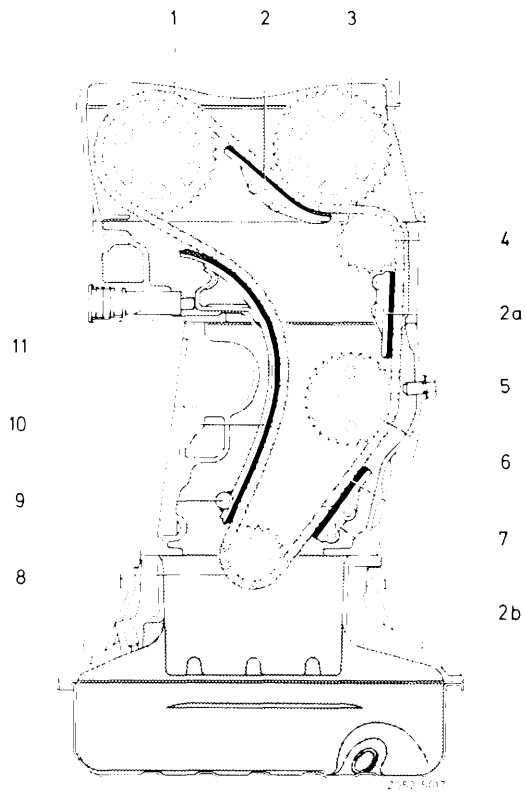

○ M 8 bolts

**Attention!**
After all bolts have been tightened, it must be possible to turn both **camshafts by hand.**

32 Install slide rail (2a). For this purpose, pull up timing chain while introducting slide rail with pliers and knocking-in bearing bolts with impact puller. Align slide rail laterally (equalize).

33 Pull up timing chain, position guide wheel (4) with left hand and knock-in lubricated bearing bolt by means of impact puller.

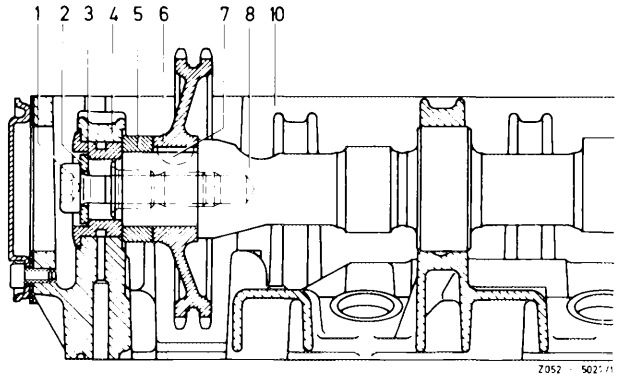
Screw-in screw connection with sealing ring.




Chain drive

1 Exhaust camshaft sprocket
2– 2b Sliding rail
3 Intake camshaft sprocket
4 Guide wheel
5 Lock bolt
6 Intermediate wheel
7 Timing chain
8 Crankshaft sprocket
9 Tensioning rail bearing pin
10 Tensioning rail
11 Hydraulic chain tensioner

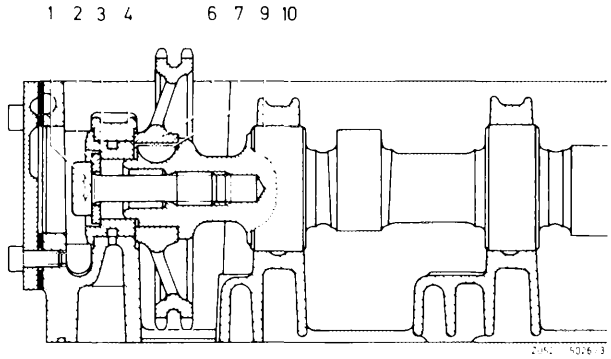
34 Install camshaft sprocket (6) of intake camshaft with spacer (5). Lubricate spacer (3) with engine oil and slide it into bearing (4).




Intake

1 Expansion bolt
2 Washer
3 Spacer
4 Bearing
5 Spacer
6 Camshaft sprocket
7 Woodruff key
8 Camshaft
10 Camshaft housing

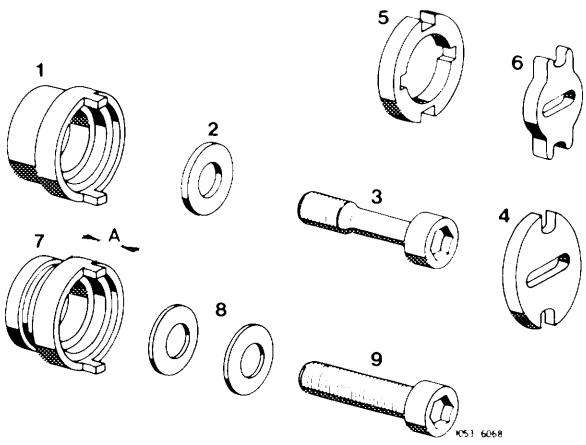
35 Install camshaft sprocket (6) of exhaust camshaft with timing chain. Lubricate spacer (3) with engine oil and slide it into bearing (4).




Exhaust camshaft

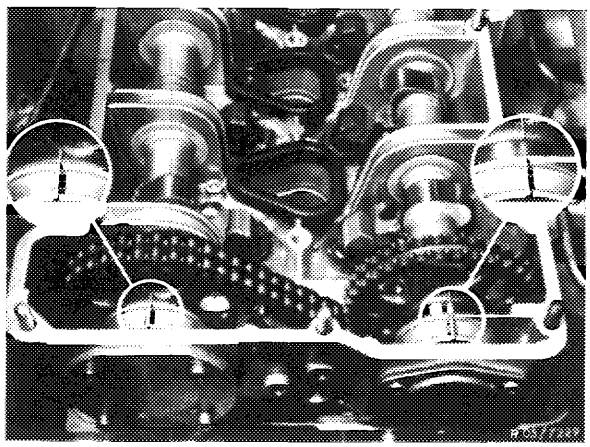
1 Expansion bolt
2 Washer
3 Spacer
4 Bearing
6 Camshaft sprocket
7 Woodruff key
9 Camshaft
10 Camshaft housing

36 During repair jobs, mount necked-down screw (3) with washer (2) only, but do not yet tighten.

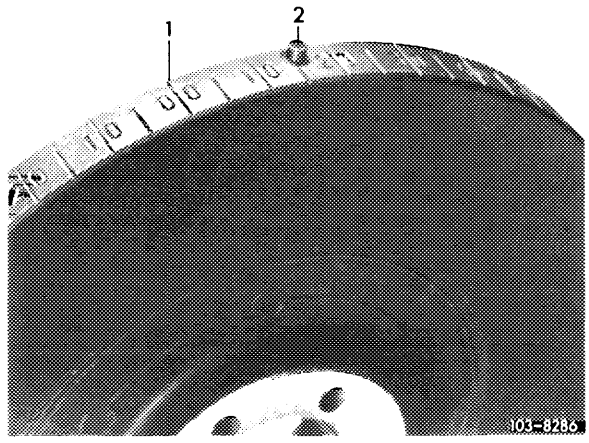



1 Spacer 2nd version without lubricating groove (for pressure oil pump and vacuum pump 2nd version)
2 Washer
3 Expansion bolt
4 Dog (for pressure oil pump and vacuum pump 2nd version)
5 Dog (for vacuum pump 1st version)
6 Dog 1st version with lubricating groove
A = 4.7 mm for vacuum pump 1st version
A = 8.3 mm for pressure oil pump and vacuum pump 2nd version
8 Spring washers (not valid)
9 Mounting bolt (not valid)

37 When 1st cylinder is at ignition TDC the adjustment marks on both camshaft sprockets and camshaft housing must align.

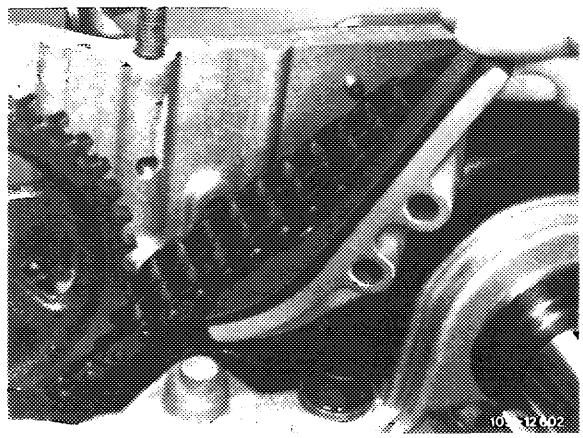


**Attention!**
If the vibration damper of an engine has a "00" mark for BDC in addition to TDC, the TDC mark is next to pin (2) in the vibration damper.




1 TDC mark

38 Install sliding rail in camshaft housing so that the timing chain cannot jump.

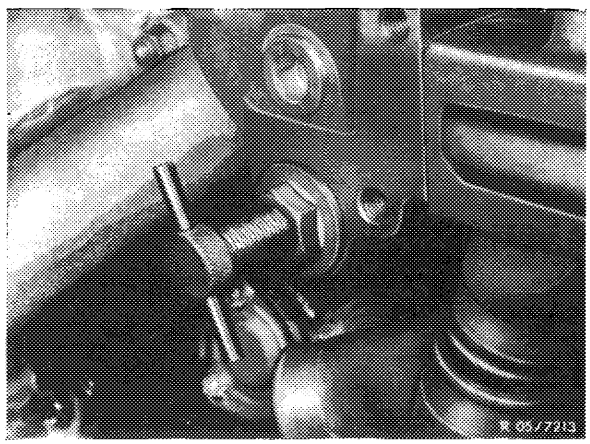


39 Install rigid chain tensioner and tighten by hand.

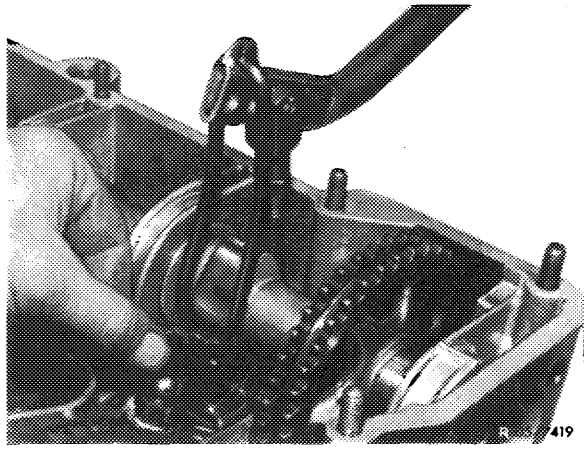
40 Turn crankshaft with combination tool and adjust to ignition TDC. Check adjustment marks (fig. of point 37).

Check timing, if cylinder head or camshaft housing surfaces have been faced (05–215).

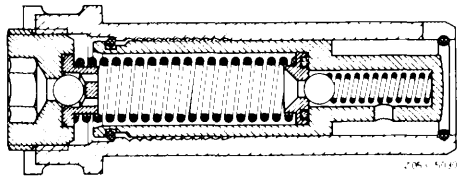
41 Tighten necked-down screw for camshaft sprocket to 80 Nm (8 kpm), while applying counterhold to camshaft by means of holding wrench.



42 Install rocker arms and spring clamps (05–230).

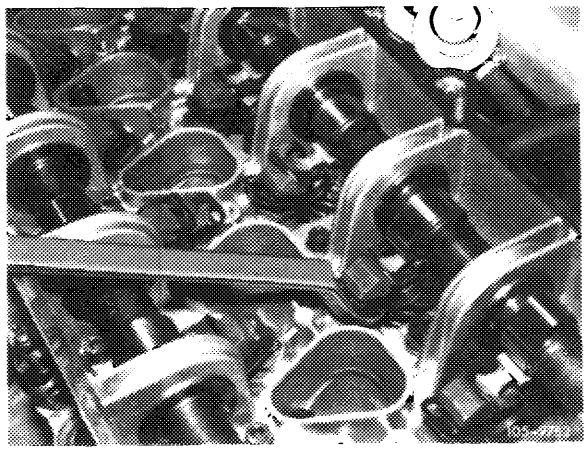


43 Position chain tensioner for insallation and install (05–310).



44 Adjust valve clearance (05–210).

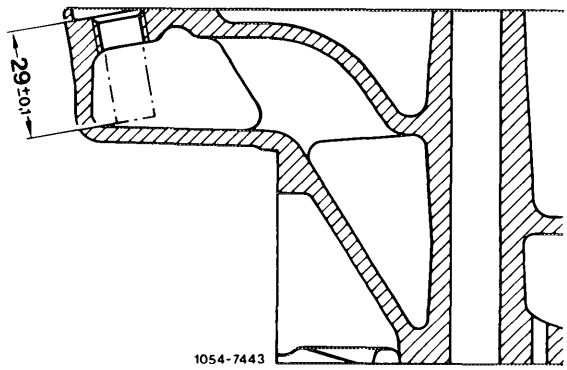
Further installation instructions in reverse sequence of removal.

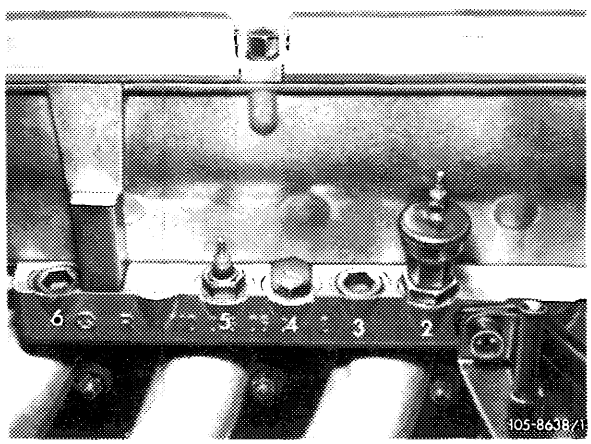


**Note**

The measuring sensor box must be equipped to agree with the engine version.

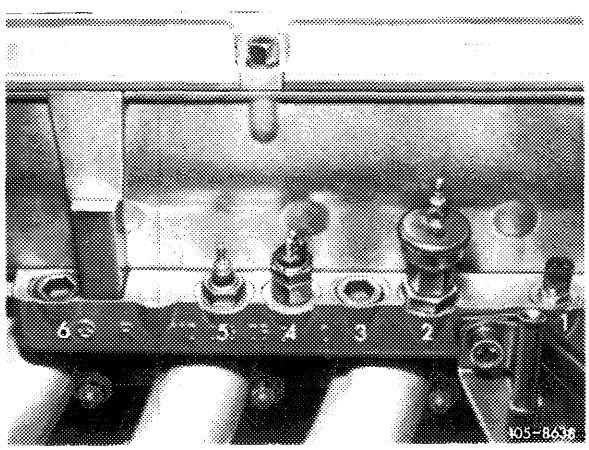
Note screwed depth and use seals of sufficient thickness.



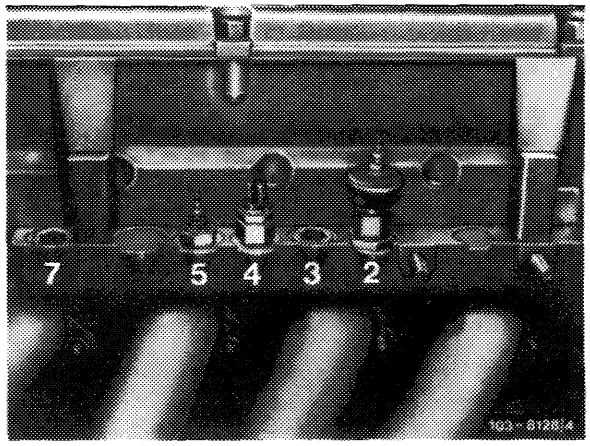

Measuring sensor box for **carburator engine** with **air conditioner**

2 100°C temperature switch and adaptor for extra fan/air conditioner
3 Core plug M 22 x 1.5
4 Plug M 14 x 1.5
5 Coolant temperature gage sensor
6 Core plug M 22 x 1.5



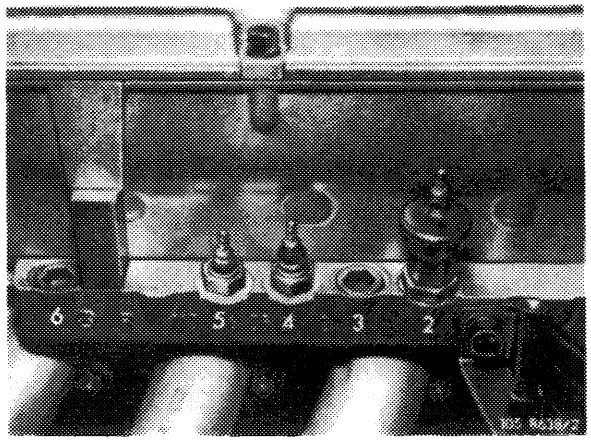

Measuring sensor box for **fuel injection engine** with **air conditioner**

1 Coolant temperature sensor for control unit
2 100°C temperature switch and adaptor M 18 x 1.5 for extra fan/air conditioner
3 Core plug M 22 x 1.5
4 Temperature timing switch for cold starts
5 Coolant temperature gage sensor
6 Core plug M 22 x 1.5




Measuring sensor box for **continuous fuel injection engine** with **air conditioner**

2 100°C temperature switch and adaptor M 18 x 1.5 for extra fan/air conditioner
3 Core plug M 22 x 1.5
4 Temperature timing switch for cold starts
5 Coolant temperature gage sensor
7 Core plug M 22 x 1.5




Measuring sensor box for **carburetor engine USA** with **air conditioner**

2 100°C temperature switch and adaptor M 18 x 1.5 for extra fan/air conditioner and exhaust gas recirculation
3 Core plug M 22 x 1.5
4 65°C temperature switch (exhaust gas recirculation)
5 Coolant temperature gage sensor
6 Core plug M 22 x 1.5

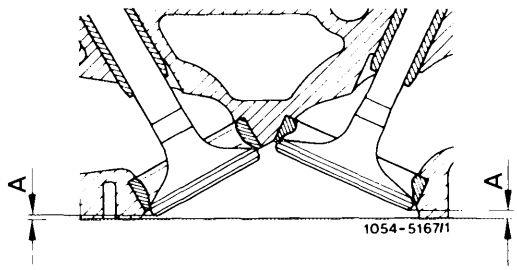
**Data**

| | | |
|---|---|---|
| Total cylinder head height | | 93.9–94.0 |
| Min. height after machining | | 93.1 |
| Permissible unevenness of mating surfaces | in longitudinal direction | 0.08 |
| | in cross direction | 0.0 |
| Permissible deviation in parallel of upper mating surface to lower mating surface in longitudinal direction | | 0.1 |
| Peak to valley height | | 0.010 |
| Pressure test with air under water in bar gauge pressure | | 2 |

| | | Minimum distance A with new valves and new valve seats, cylinder head parting surface not machined | Minimum distance A with new valves and new valve seats, cylinder head parting surface 0.4 mm milled off |
|---|---|---|---|
| Intake | | 3.3 | 2.9 |
| Exhaust | Valve retainer dia. 37 mm | 0.6 | 0.2 |
| | Valve retainer dia. 39 mm | 0.04 | 0.36 standout |

| | | Max. distance A with new valves and machined valve seats, cylinder head parting surface not machined | Max. distance A with new valves and machined valve seats, cylinder head parting surface 0.4 mm milled off |
|---|---|---|---|
| Intake | | 4.2 | 3.8 |
| Exhaust | Valve retainer dia. 37 mm | 1.5 | 1.1 |
| | Valve retainer dia. 39 mm | 0.94 | 0.54 |

Max. distance A is reduced by the same dimension by which the cylinder head parting surface has been machined down.



**Conventional tools**

| | |
|---|---|
| Surface grinding machine with milling equipment for light alloy surface | e.g. made by Ruaro u. Fi., Schio/Italy Scledum, type RTY |
| Knife-edged straightedge approx. 750 mm long | |

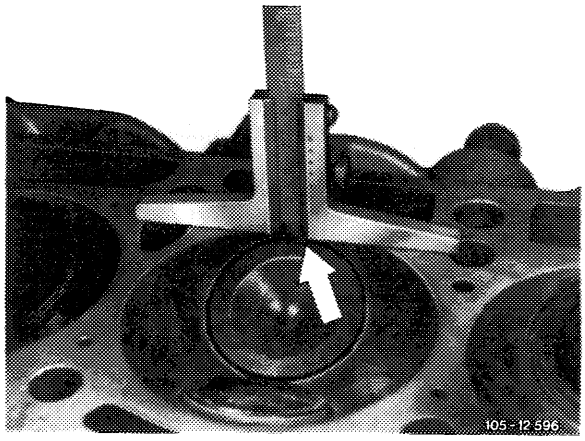
**Facing**

Only 0.4 mm material can be machined off of the cylinder head at the mating surfaces to the crankshaft and camshaft housing.

A distorted cylinder head must always be faced on both mating surfaces.

Machine valve seats until the permissible distance A between the valve head and cylinder head mating surface is reached.

The timing must be adjusted, if a cylinder head mating surface is faced (05–215).

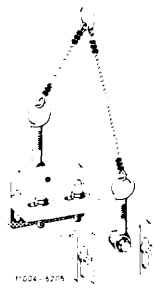


# 01–420 Pressure testing cylinder head

## Data

| | |
|---|---|
| Pressure test with air under water in bar gauge pressure | 2 |

## Special tools

| | | |
|---|---|---|
| Pressure testing plate | | 110 589 00 25 00 |
| Suspension fixture |  | 110 589 34 63 00 |

## Conventional tool

| | |
|---|---|
| Electrically heated sink | e.g. made by Otto Dürr, D-7123 Sachsenheim-Ochsenbach |

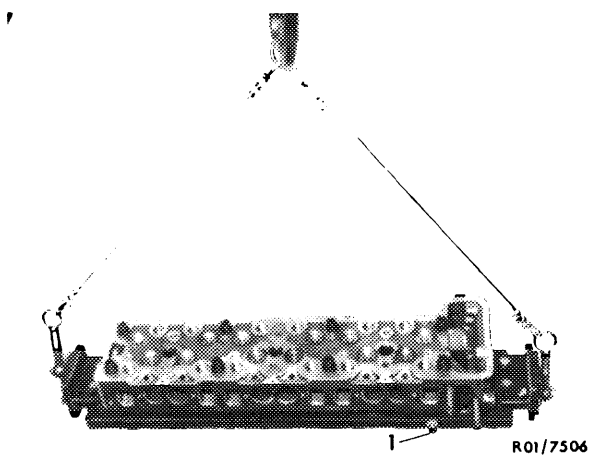
## Pressure testing

If the loss of water indicates cracks, the cylinder head must be pressure tested.

1 Bolt pressure testing plate to a cleaned cylinder head.

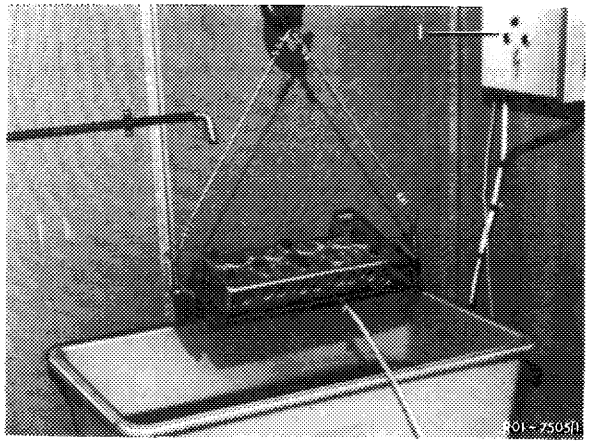
2 Plug holes and connections.

3 Connect compressed air hose (1) and regulate compressed air to 2 bar gauge pressure.



4 Attach cylinder head to suspension device and lower into heated water (80°C).

5 Find location of leaks, if air bubbles rise.



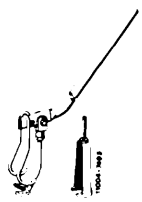
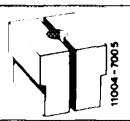
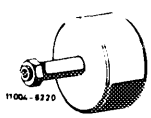
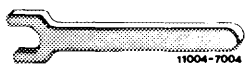
**Data**

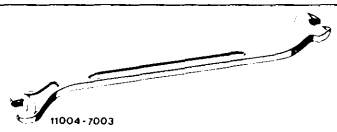
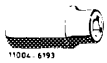
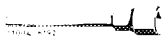
| Valve clearance | Cold engine (ca. 20°C) | Warm engine (60°C ± 15°C) |
|---|---|---|
| Intake | 0.10[1]) | 0.15[1]) |
| Exhaust | 0.25 | 0.30 |

[1]) 0.05 mm more for consistent outside temperatures below −20°C.

| **Tightening torques** | Nm |
|---|---|
| Cylinder head bolts M 12 x 1.5 | 110 |
| Bolts M 8 for camshaft housing to cylinder head and crankcase | 25 |
| Expansion bolt for camshaft sprockets | 80 |
| Ball locating ring in chain tensioner | 25 |
| Valve adjusting screw | 20–40 |
| Cylinder head cover bolts and capped nuts | 5 |
| Level control pump to camshaft housing | 9 |

**Special tools**

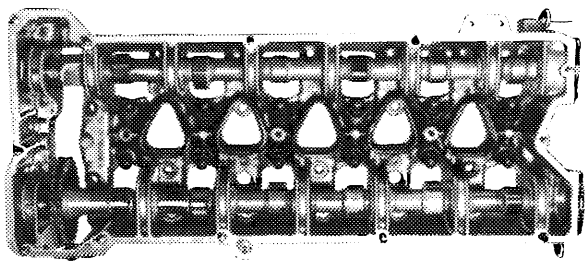
| | | |
|---|---|---|
| Rocker arm removal and installation tool |  | 110 589 04 61 00 |
| Rigid chain tensioner | | 110 589 03 31 00 |
| Chain tensioner holder |   | 110 589 02 31 00 |
| Bearing pin impact extractor (basic unit) |   | 116 589 20 33 00 |
| M 6 x 50 bolt for impact extractor | | 116 589 01 34 00 |
| Holding wrench for camshafts |   | 116 589 01 01 00 |

| | | |
|---|---|---|
| Valve adjusting wrench 17 mm |  | 110 589 01 01 00 |
| Socket 27 mm to turn engine |  | 001 589 65 09 00 |
| 10 mm wrench socket 1/2" square, 140 mm long |  | 000 589 05 07 00 |

**Note**

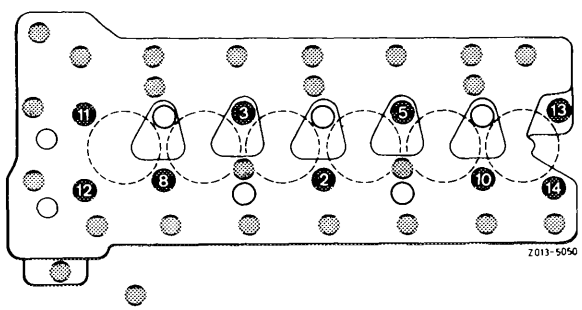
Camshaft housing may only be removed after engine is cold.

The camshaft housing must be removed to remove the camshafts and valve springs or to replace the valve seals.



105-8003

**Attention!**
On exchange engines starting unit no. 496.861 (starting October 1977) 9 cylinder head screws with a **length** of **150 mm** are used instead of 145 mm in combination with camshaft housings which are countersunk by 5 mm at the 9 bolt head supporting points 2, 3, 5, 8, 10, 11, 12, 13 and 14.
These cylinder head bolts must be installed together with a washer part no. 186 990 09 40 (5 mm high), since otherwise the thread lugs in cylinder crankcase may be forced off.



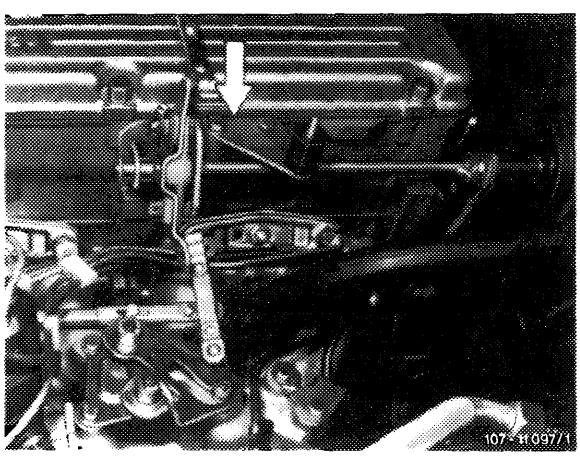

Z013-5050

For engines with CIS, use camshaft housing with lug for attaching air cleaner (arrow).

Camshaft housings with repair stages are available for camshaft with reground bearing journals (01–471).

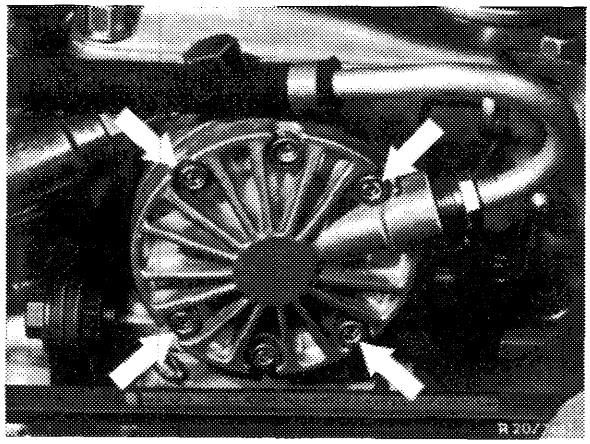
Exchange engines are in part supplied with camshaft bearing intermediate stages and repair stages (01–471).

Also refer to 01–471, association camshaft housing and camshafts.



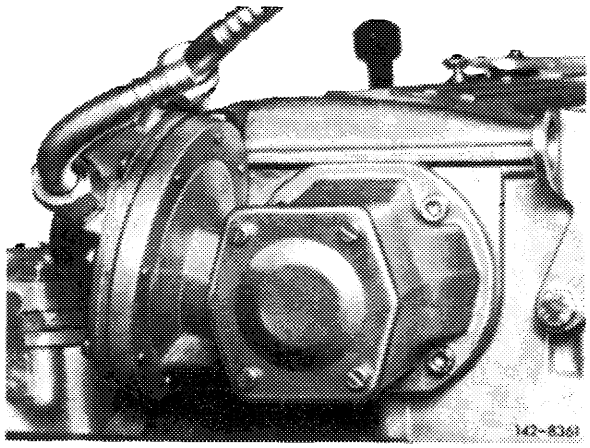
## Removal

1 Remove pressure oil pump of models with level control and place to one side without disconnecting the lines. This requires loosening only those bolts marked with an arrow.

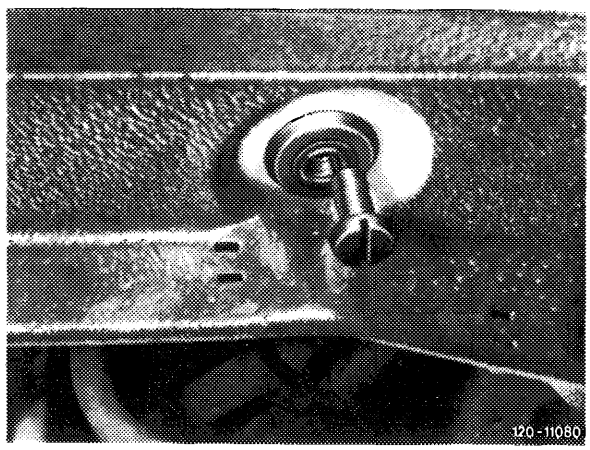


2 Remove compressor of models with an air conditioner.

3 Remove vacuum pump of models in USA version.

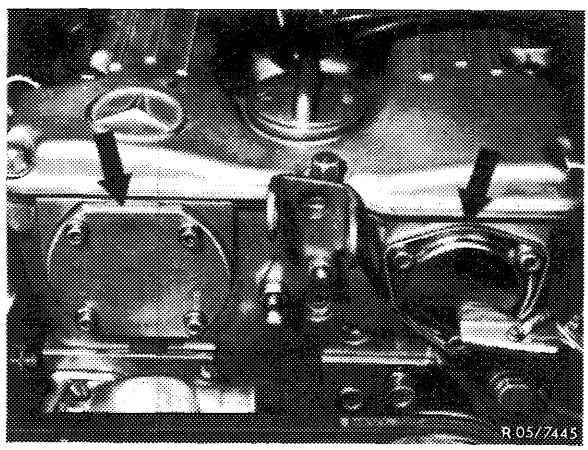


4 Drain coolant from radiator and remove upper water hose from engine to radiator. Remove cylinder head cover.

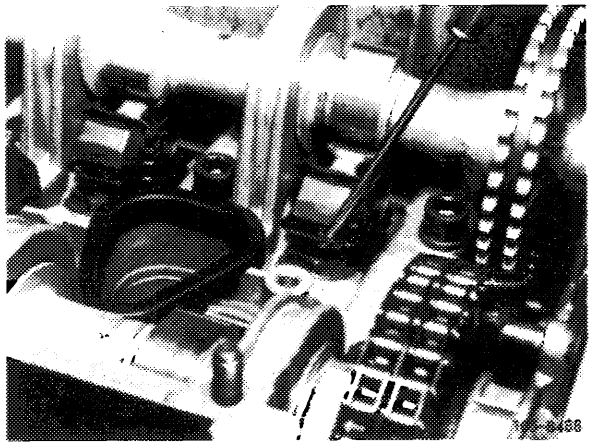



Radiator drain plug of type 123.

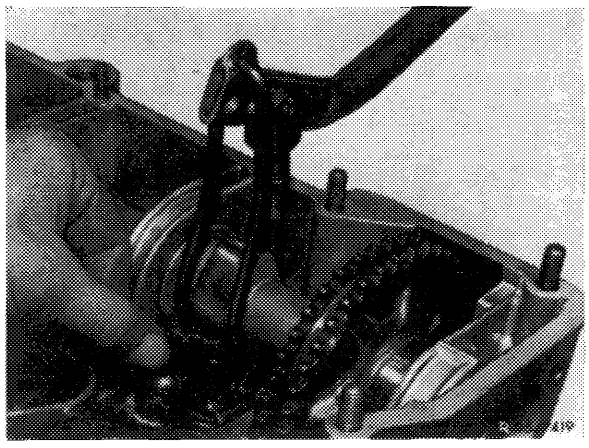
5 Unscrew right cover (arrow) on front of camshaft housing.



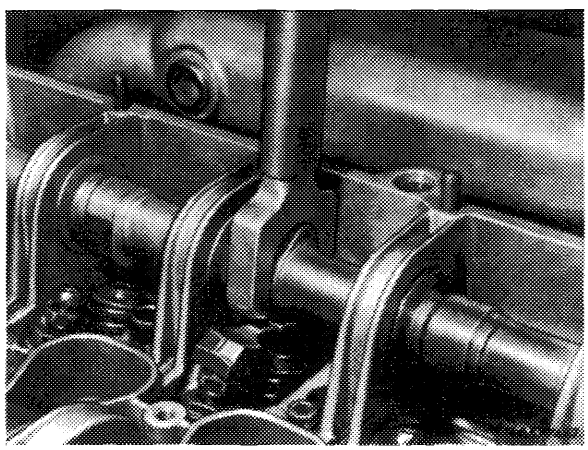
6 Remove all spring clamps with a wrench socket.



7 Remove all rocker arms with removal and installation tool.



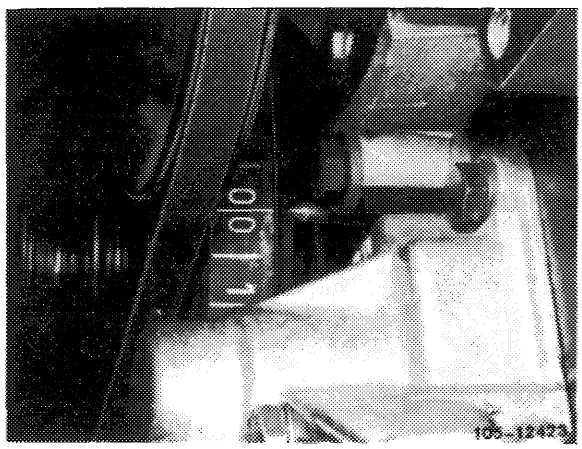
8 Counterhold only the right camshaft (exhaust) with the holding wrench and loosen the camshaft sprocket mounting expansion bolt.



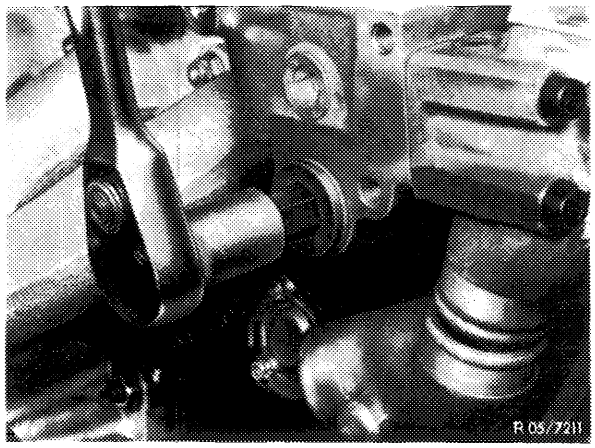
9 Position piston 1 at ignition TDC and both camshafts at marks.

This requires turning the crankshaft with the combination tool.

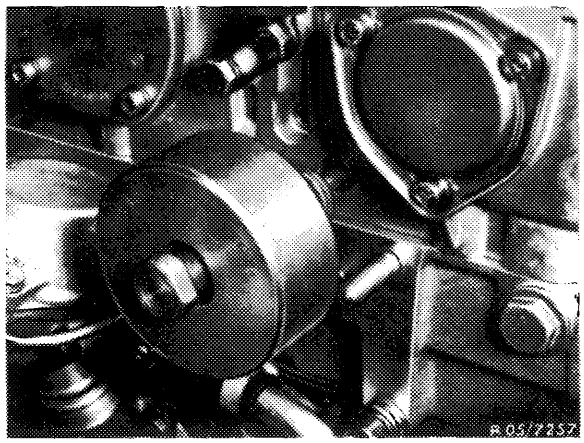
**Attention!**
Do not turn engine at the mounting bolts of the camshaft sprockets. Don't turn engine in **reverse direction** of rotation.



10 Remove chain tensioner and pressure spring (05–310).



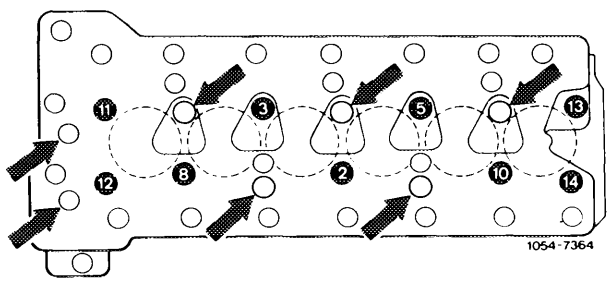
11 Remove sliding rail in camshaft housing. This requires knocking out bearing pins with an impact extractor.



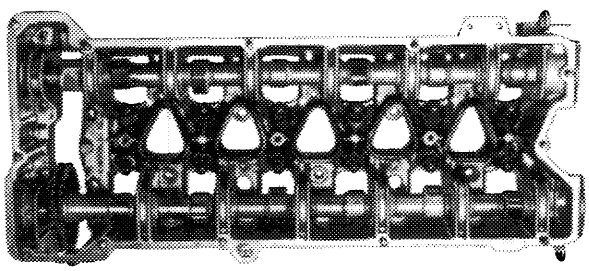
12 Push back righthand camshaft and remove camshaft sprocket.

13 Guide camshaft into bearings again. Unscrew M 8 bolts and cylinder head bolts in reverse sequence of tightening.

**Do not loosen the 5 cylinder head bolts positioned deeper (arrows) and the 2 M 8 bolts (arrows).**

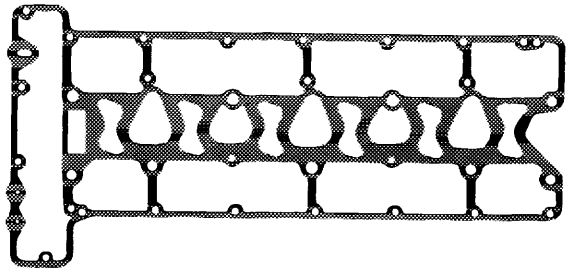



14 Remove camshaft housing with camshafts.



**Installation**

15 Clean mating surface on cylinder head and camshaft housing to remove grease and install **sheet metal foil, part number 110 016 06 80,** without a sealing compound.

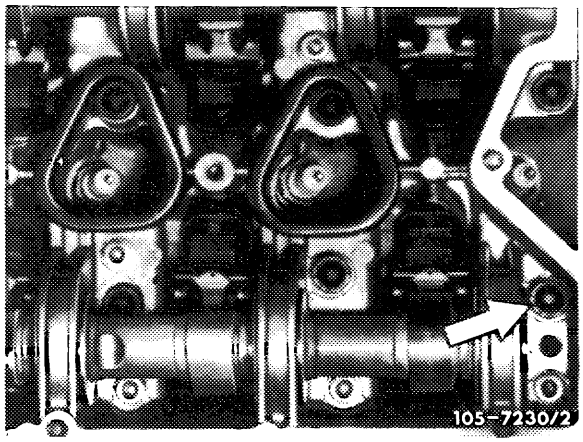


105 - 12 599

16 Install camshaft housing.

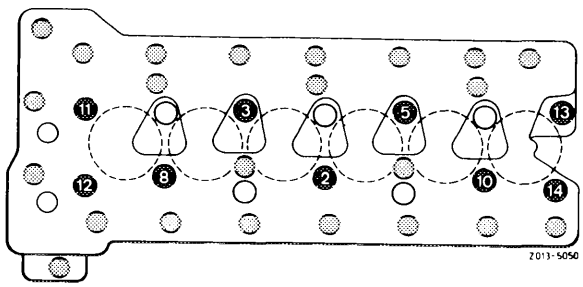
17 Lubricate threads and cylinder head surfaces of cylinder head bolts before installation.

**Attention!**
Since July of 1974 the clearance on the camshaft housing for **22 mm dia. washer** of cylinder head bolt No. 14 has been extended. Use the former 20 mm dia. washer (arrow) on former camshaft housings.



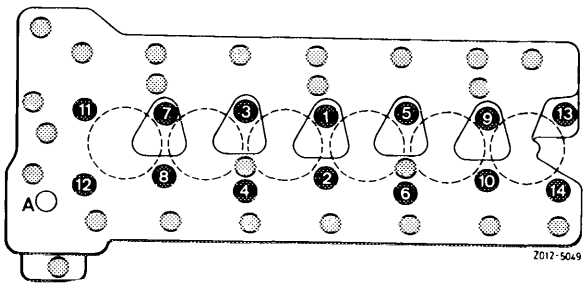

18 Tighten cylinder head bolts in steps in the sequence of tightening.

1st step: to **70 Nm** (7 kpm) starting with bolt No. 2.



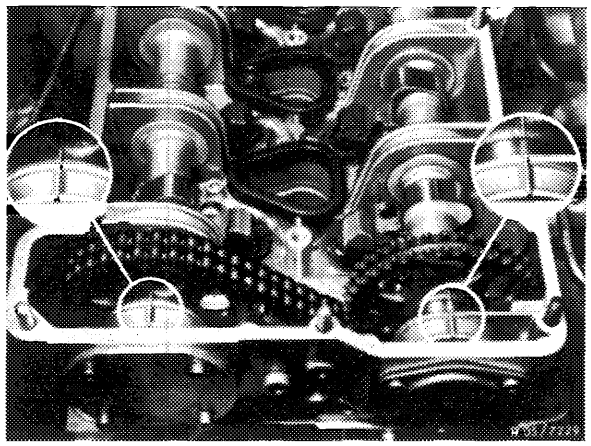

2nd step: all cylinder head bolts to **110 Nm** starting with bolt No. 1. This requires first loosening the five cylinder head bolts 1, 4, 6, 7 and 9 located deeper **separately** somewhat.

Tighten the M 8 bolts from inside to outside to 25 Nm.

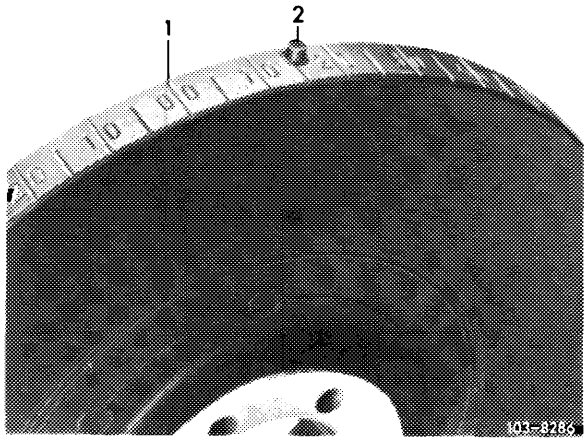



**Attention!**
After tightening all bolts, it must be possible to **turn both camshafts by hand.**

19 Install right camshaft sprocket making sure that the adjustment marks of both camshafts align when the crankshaft is at TDC.

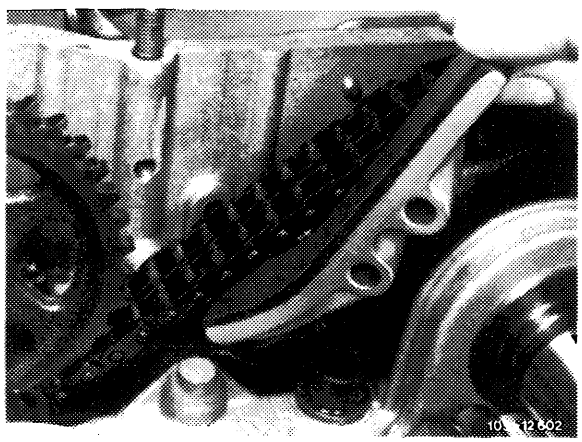


**Attention!**
When the vibration damper of an engine has a ,,0/0'' mark for BDC in addition to TDC, the TDC mark is next to the pin in the vibration damper.




1 TDC mark

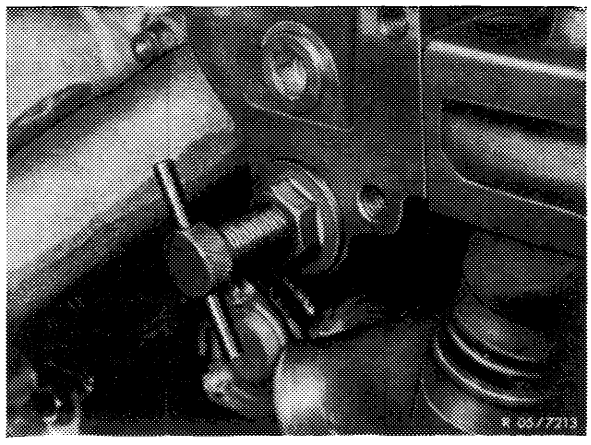
20 Install sliding rail so that the timing chain cannot jump.



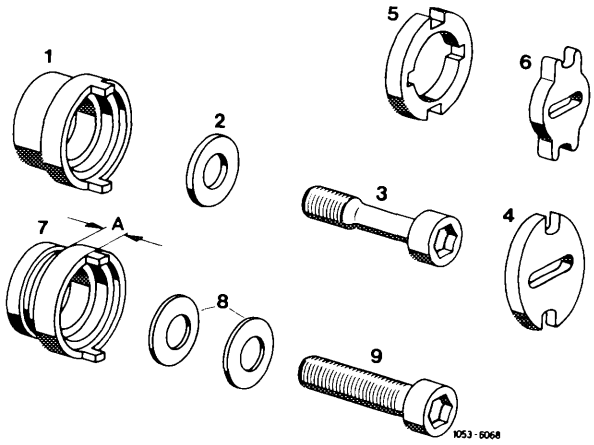
21 Install ,,rigid'' chain tensioner and tighten by hand.

**Attention!**
If camshaft housing has been ground, the timing must be adjusted.

22 Lubricate spacers with engine oil and slide them into camshaft housing.

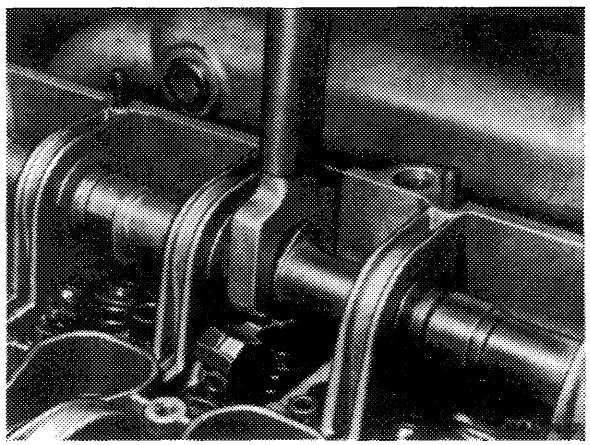


1 Spacer 2nd version without lubrication groove (for pressure oil pump and vacuum pump 2nd version)
2 Washer
3 Expansion bolt
4 Dog (for pressure oil pump and vacuum pump 2nd version)
5 Dog (for vacuum pump 1st version)
6 Dog 1st version (for oil pump)
7 Spacer 1st version with lubrication groove
A = 4.7 mm for vacuum pump 1st version
A = 8.3 mm for pressure oil pump and vacuum pump 2nd version
8 Spring washers (not valid)
9 Mounting bolt (not valid)

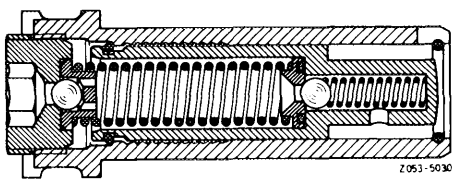



23 Torque expansion bolt for camshaft sprocket to 80 Nm (8 kpm), counterholding camshaft with the holding wrench.

**Note:** Washer (2) with 30 mm OD is not fitting into spacing sleeve for vacuum pump on USA vehicles up to January 1973. In such a case, machine OD of washer (2) down by approx. 1 mm.



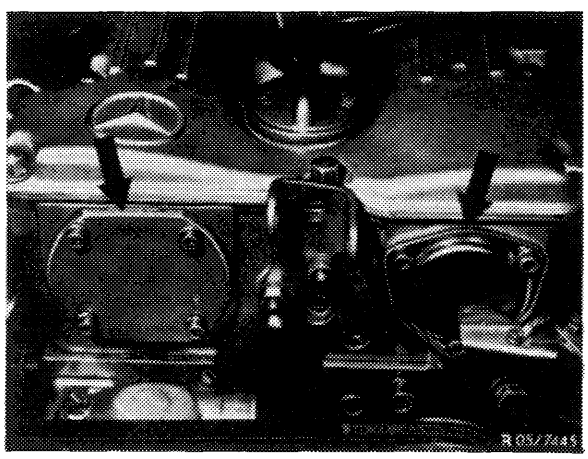
24 Position chain tensioner for installation and install. Also install pressure spring (05–310).




Chain tensioner in installation position

25 Install cover on front of camshaft housing and install level control pump or vacuum pump with gaskets.

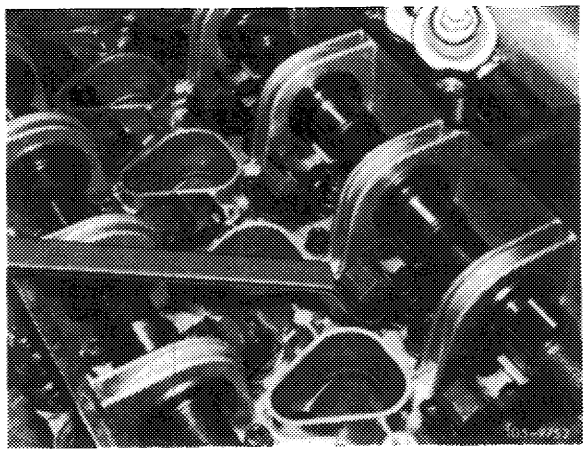
26 Install rocker arms (05–230).



27 Adjust valve clearance (05–210).

28 Complete engine.

**Note:** If the camshaft housing has been faced, readjust timing (05–215).



**Note**

Exchange engines are in part supplied with camshaft bearing intermediate stages and repair stages. In the event of repairs, install pertinent camshafts with reduced bearing dia. Also refer to table: Camshaft housing with 11 bearing points.

Camshaft housings with repair stages are available for camshafts with reground bearing journals. Also refer to table: Camshaft housing with 11 bearing points.

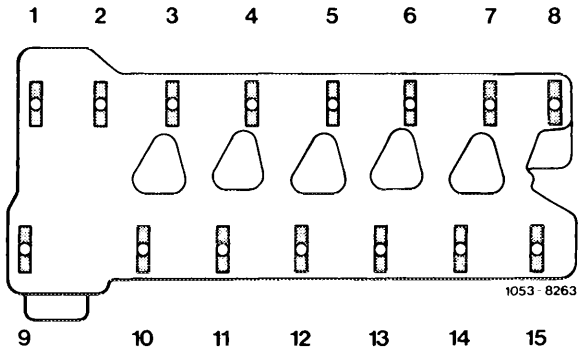
**Camshaft housing with 15 bearing points**

| Bearing points | | 1, 9 | 2 | 3, 10, 11 | 4,5,12,13 | 6,7,14,15 | 8 |
|---|---|---|---|---|---|---|---|
| Standard dimension | bearing dia. | 38.016<br>38.000 | 50.066<br>50.050 | 50.016<br>50.000 | 51.519<br>51.500 | 53.019<br>53.000 | 54.019<br>54.000 |
| | journal dia. | 23.993<br>23.980 | 49.950<br>49.934 | 49.950<br>49.934 | 51.440<br>51.421 | 52.940<br>52.921 | 53.940<br>53.921 |
| Intermediate stage –0.1 mm (exchange engines) | bearing dia. | | 49.966<br>49.950 | 49.916<br>49.900 | 51.419<br>51.400 | 52.919<br>52.900 | 53.919<br>53.900 |
| | journal dia. | | 49.850<br>49.834 | 49.850<br>49.834 | 51.340<br>51.321 | 52.840<br>52.821 | 53.840<br>53.821 |
| Repair stage 1 –0.25 mm | bearing dia. | | 49.816<br>49.800 | 49.765<br>49.750 | 51.269<br>51.250 | 52.769<br>52.750 | 53.769<br>53.750 |
| | journal dia. | | 49.700<br>49.684 | 49.700<br>49.684 | 51.190<br>51.171 | 52.690<br>52.671 | 53.690<br>53.671 |
| Repair stage 2 –0.50 mm | bearing dia. | | 49.566<br>49.550 | 49.516<br>49.500 | 51.019<br>51.000 | 52.519<br>52.500 | 53.519<br>53.500 |
| | journal dia. | | 49.450<br>49.434 | 49.450<br>49.434 | 50.940<br>50.921 | 52.440<br>52.421 | 53.440<br>53.421 |
| Camshaft bearing play | radial | 0.057<br>0.124 | 0.100<br>0.132 | 0.050<br>0.082 | 0.060<br>0.098 | 0.060<br>0.098 | 0.060<br>0.098 |
| | axial | 0.050<br>0.120 | | | | | |
| Sleeve for bearing a | OD | 37.950<br>37.925 | ID | 24.013<br>24.000 | | | |

**Combinations in the event of repairs**

a) Camshaft housing with 15 bearing points intake-camshaft code number 25, 67 and 33 with 7 bearing journals.

Exhaust-camshaft code number 24, 30, 57 and 71 with 8 bearing journals.

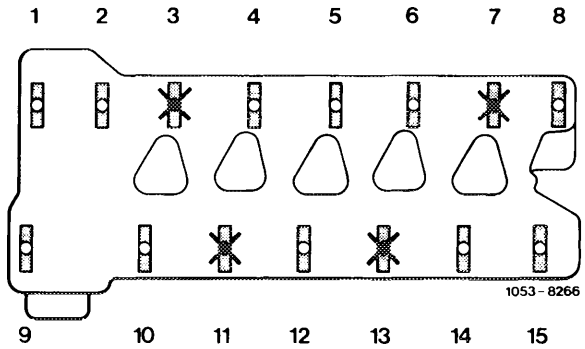



b) Camshaft housing with 15 bearing points, with bearing points 11 and 13 at intake end or 3 and 7 at exhaust end out of function.

Intake camshaft code number 74 and 91 with 5 bearing journals and intermediate stage or repair camshafts with reduced bearing dia.

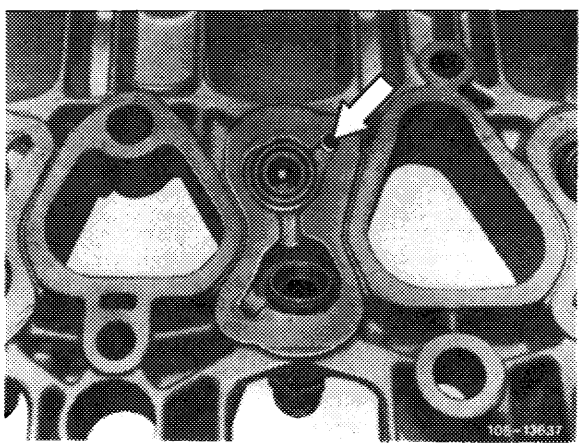
Exhaust camshaft code no. 78 and 95 with 6 bearing journals and intermediate stage or repair camshafts with reduced bearing dia.

In this case, the oil bores of bearing points 11 and 13 or 3 and 7 on removed camshaft housing must be closed.




X close oil bores

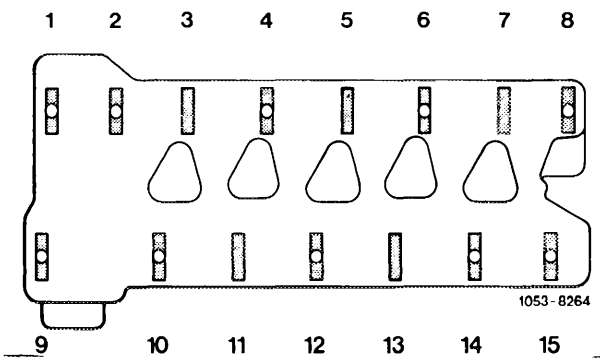
For this purpose, cut threads M 6, approx. 10 mm deep from below into oil bores (arrow) and screw-in threaded plug 000 913 006 110 with sealing compound.



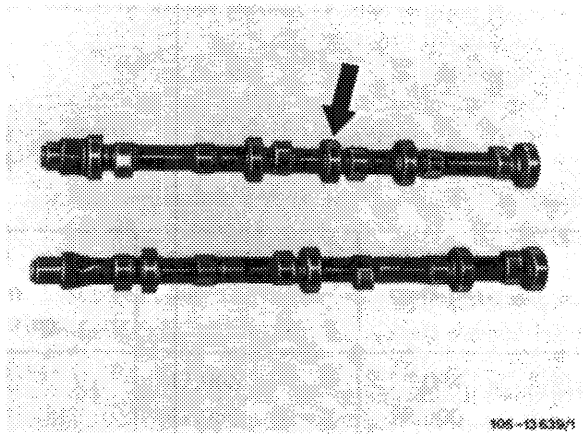
c) Camshaft housing with 15 bearing points, with bearing points 11 and 13 (intake end) or bearing points 3.5 and 7 (exhaust end) without oil supply.

Intake-camshaft code number 25, 67 and 33 with 7 bearing points, of which bearing points 11 and 13 with 1 mm machined off.

Exhaust-camshaft code number 24, 57, 71 and 30, of which bearing points 3, 5 and 7 machined off by 1 mm.



Exchange engines starting unit no. 464.130 are supplied in this version (c). When installing an exhaust-camshaft with code number 78 and 95 into camshaft housing version c, machine 1 mm from bearing journal 5 (arrow).

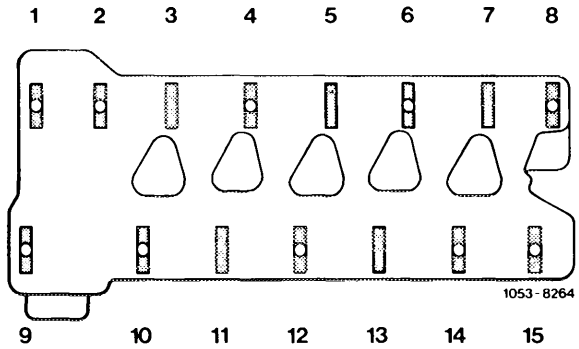


**Camshaft housing with 15 bearing points of which 5 bearing points without oil bore**

| Bearing points | | 1, 9 | 2 | 3, 11 | 4, 12 | 5, 13 | 6, 14, 15 | 7 | 8 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Bearing points | Bearing dia. | 38.016 / 38.000 | 50.066 / 50.050 | 51.0 | 51.519 / 51.500 | 52.5 | 53.019 / 53.000 | 54.0 | 54.019 / 54.000 | 50.016 / 50.000 |
| | Journal dia. | 23.993 / 23.980 | 49.950 / 49.934 | – | 49.950 / 49.934 | – | 52.940 / 52.921 | – | 53.940 / 53.921 | 49.950 / 49.934 |

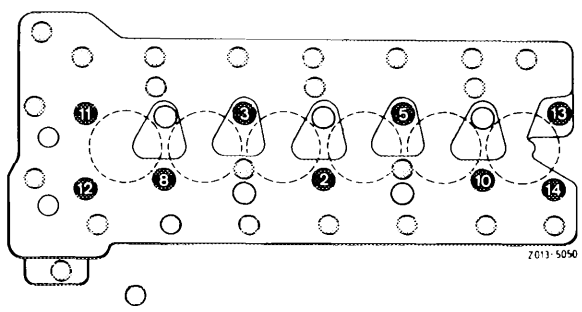
This camshaft housing is not manufactured as an intermediate or repair stage.

On this camshaft housing, the bearing points 3, 5, 7, 11 and 13 are without oil bore and their ID is 1 mm larger than the respective camshaft bearing journals. This camshaft housing can be used to install **all camshafts with normal dimension.**




This camshaft housing is attached together with cylinder head by means of 9 cylinder head bolts, M 12 x 145 mm (formerly M 12 x 150 mm), since the bolt head contact surfaces in camshaft housing were countersunk by 5 mm.

**Attention!**
On exchange engines starting unit number 496.861 (approx. starting October 1977) these 9 cylinder head bolts are installed with a length of 150 mm. Washers 5 mm thick part no. 186 990 09 40 are fitted to make sure that the thread lugs in cylinder crankcase are not forced off.



**Camshaft housing with 11 bearing points, of which 1 bearing point without oil bore**

| Bearing points | | 1, 9 | 2 | 4, 12 | 5 | 6, 14, 15 | 8 | 10 |
|---|---|---|---|---|---|---|---|---|
| Bearing points | Bearing dia. | 38.016 / 38.000 | 50.066 / 50.050 | 51.519 / 51.500 | 52.5 | 53.019 / 53.000 | 54.019 / 54.000 | 50.016 / 50.000 |
| | Journal dia. | 23.993 / 23.980 | 49.950 / 49.934 | 51.440 / 51.421 | | 52.940 / 52.921 | 53.940 / 53.921 | 49.950 / 49.934 |

Intermediate stage – 0.1 mm (exchange engines only)

Camshaft housing part no. 110 010 20 36
Intake camshaft part no. 110 051 **77** 01
Exhaust camshaft part no. 110 051 **98** 01

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Bearing dia. | 49.966 / 49.950 | 51.419 / 51.400 | 52.5 | 52.919 / 52.900 | 53.919 / 53.900 | 49.916 / 49.900 |
| Journal dia. | 49.850 / 49.834 | 51.340 / 51.321 | | 52.840 / 52.821 | 53.840 / 53.821 | 49.850 / 49.834 |

Repair stage 1 – 0.25 mm

Camshaft housing part no. 110 010 21 36
Intake camshaft part no. 110 051 **75** 01
Exhaust camshaft part no. 110 051 **79** 01

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Bearing dia. | 49.816 / 49.800 | 51.269 / 51.250 | 52.5 | 52.769 / 52.750 | 53.769 / 53.750 | 49.765 / 49.750 |
| Journal dia. | 49.700 / 49.684 | 51.190 / 51.171 | | 52.690 / 52.671 | 53.690 / 53.671 | 49.700 / 49.684 |

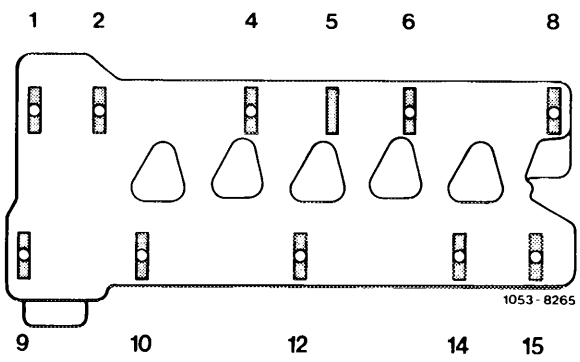
Repair stage 2 – 0.50 mm

Camshaft housing part no. 110 010 22 36
Intake camshaft part no. 110 051 **76** 01
Exhaust camshaft part no. 110 051 **80** 01

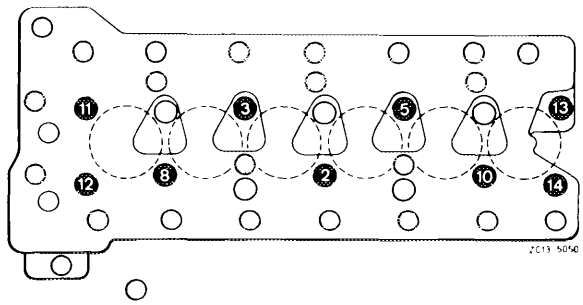
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Bearing dia. | 49.566 / 49.550 | 51.019 / 51.000 | 52.5 | 52.519 / 52.500 | 53.519 / 53.500 | 49.516 / 49.500 |
| Journal dia. | 49.450 / 49.434 | 50.940 / 50.921 | | 52.440 / 52.421 | 53.440 / 53.421 | 49.450 / 49.434 |

On this camshaft housing bearing point 5 is without oil bore and its ID is 1 mm larger than the respective camshaft bearing journal.

This camshaft housing can be used to install camshaft without changes on bearing journals.



This camshaft housing is attached together with cylinder head by means of 9 cylinder head bolts M 12 x 145 (formerly M 12 x 150), since the bolt head contact surfaces in camshaft housing were countersunk by 5 mm.




**Attention!**
On exchange engines starting unit number 496.861 (approx. starting October 1977) these 9 cylinder head bolts are installed with a length of 150 mm. Washers 5 mm thick part no. 186 990 09 40 are fitted to make sure that the thread lugs in cylinder crankcase are not forced off.

## 01–472 Facing camshaft housing

**Data**

| | |
|---|---|
| Total height of new camshaft housing | 104.8–105.0 |
| Min. height after machining | 104.0 |
| Permissible deviation from parallel between upper and lower parting surface in longitudinal direction | 0.1 |
| Mean height of roughness of parting surfaces | 0.006–0.014 |

**Conventional tools**

| | |
|---|---|
| Surface grinding machine with milling equipment for light alloy surfaces | e.g. made by Ruaro u. Fi., Schio/Italy Scledum, type RTY |
| Knife-edged straightedge approx. 750 mm long | |

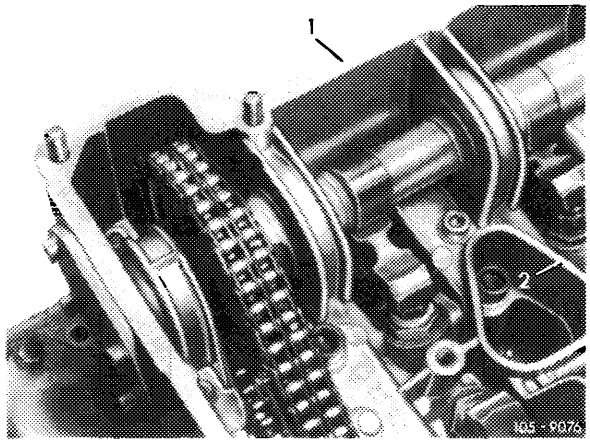
**Note**

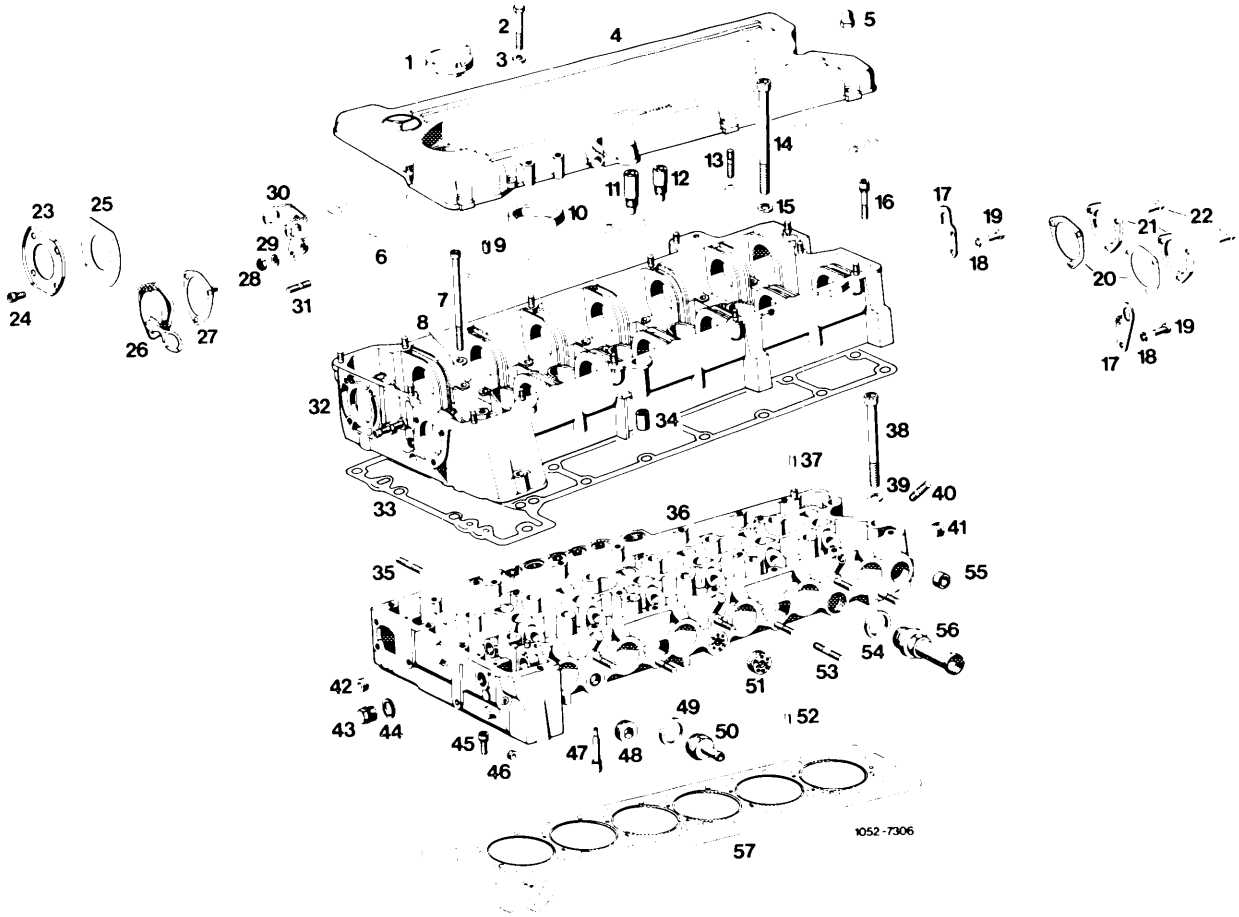
The camshaft housing may only be faced, if mechanical damage is visible on the mating surfaces.

A distorted camshaft housing will align with the cylinder head when tightened.

Only 0.4 mm may be machined off of the camshaft housing mating surfaces to the cylinder head or cylinder head cover. The same amount of material must be removed from the bearing surfaces for the gaskets at the spark plugs (2) as was machined from the mating surface to the cylinder head cover (1).

If the camshaft housing was faced, the timing must be adjusted (05–215).






1 Filler plug
2 3 bolts M 8 x 55
3 3 seals C 8 x 13
4 Valve cover
5 Capped nuts
6 Cylinder head cover gasket
7 2 bolts M 8 x 135
8 Plain washers 38 x 15
9 3 threaded inserts M 8 x 16
10 5 cylinder head cover gaskets
11 Vent valve
12 Vent jet
13 12 studs M 8 x 18
14 9 bolts
15 9 washers
16 21 combination bolts M 8 x 40
17 2 suspension eyes, rear
18 Circlip
19 4 bolts M 8 x 15
20 2 gaskets
21 2 covers
22 6 combination bolts
23 Cover
24 7 combination bolts M 6 x 15
25 Gasket
26 Cover with holder
27 Gasket
28 2 nuts M 8
29 2 circlips
30 Suspension eyes, front
31 2 studs M 8 x 18
32 Camshaft housing
33 Sheet metal foil for repairs
34 Engine vent connecting hose
35 Stud M 8 x 30
36 Cylinder head
37 2 dowel pins 8 x 16
38 5 bolts
39 5 washers
40 Studs M 8 x 20
41 2 plugs for oil bores
42 Plug AM 22 x 1.5
43 Plug M 18 x 1.5
44 Seal A 22 x 27
45 2 combination bolts M 8 x 20
46 Plug M 10 x 1 for oil connecting bore
47 Return flow oil jet
48 Plug OM 30 x 1.5
49 Seal A 30 x 36
50 Connector for pre-heating
51 Connectors for carburetor heating
52 2 dowel pins 8 x 16
53 Stud M 8 x 35
54 Seal A 30 x 36
55 Cover for injection bore
56 Heater connection
57 Cylinder head gasket

**Conrod bolt sizes**

| Version | Part Number | Distance a and b (fig., point 1) a | b | Thread dia. d | Expansion stem dia. c when new (fig., point 1) | Min. Expansion stem dia. |
|---|---|---|---|---|---|---|
| 1st version | 110 038 01 71 | 5.5 | 3 | M 10x1 | 8.4–0.1 | 8.0 |
| 2nd version | 110 038 03 71 | | 4.5 | | | |
| 3rd version | 110 038 04 71 | 6.6 | | | | |
| Conrod bolt installation pressure | | | | | 45000 N | |

**Conrod nut torque**

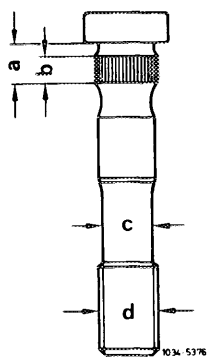
| | |
|---|---|
| Initial torque | 40–50 |
| Torque angle | 90–100° |

**Self-made tool**

| | |
|---|---|
| Steel plate | see fig., point 3 |

**Checking**

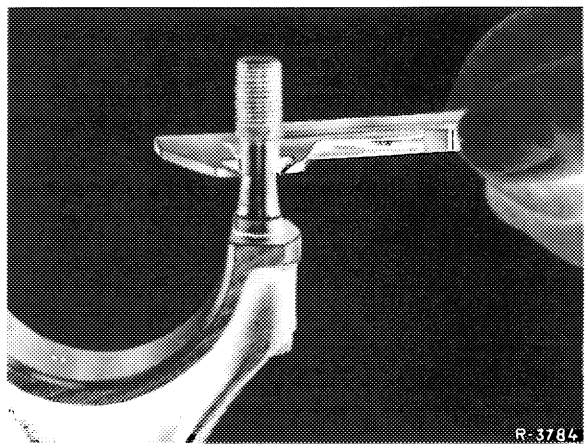
1 Measure smallest expansion stem diameter before reusing.



**Note:** If the minimum expansion stem diameter reaches or is less than 8.0 mm, **replace conrod bolt.**

Only knock out a conrod bolt to replace it.

Use third version conrod bolts for repairs.

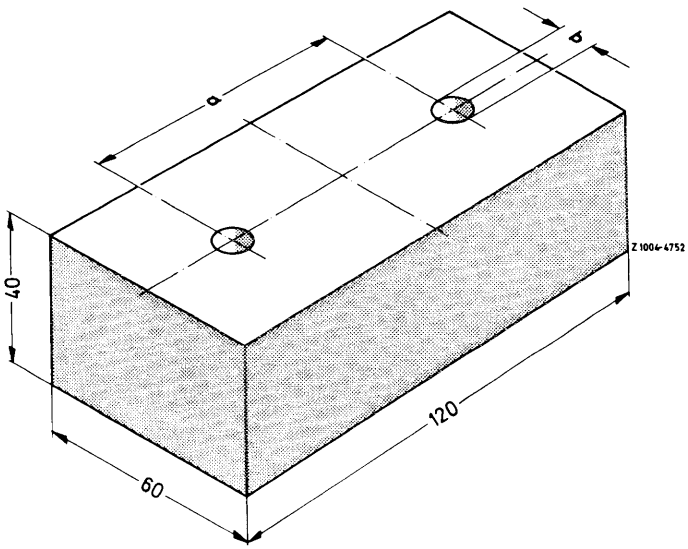



## Replacing

2 Knock out conrod bolts.

3 Press new bolts into conrod with a pressure of about 45000 N, or knock in with a hammer and mandrel.

Place the connecting rod on a ground steel plate when knocking in or pressing in conrod bolts.



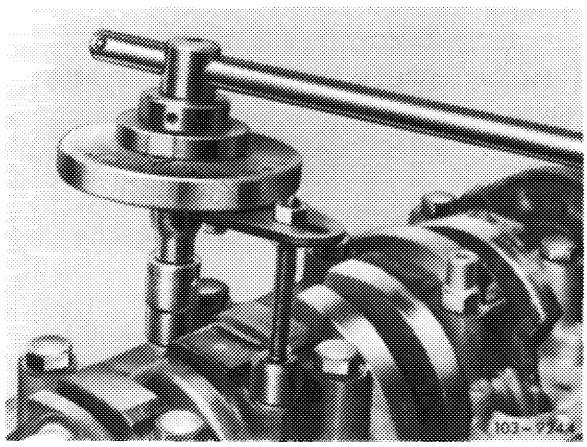

Distance between holes a = 64.6 mm
Bore b = 11 mm

## Tightening

4 Lubricate nuts and threads.

5 Tighten conrod nuts to a torque pressure of 40–50 Nm and a torque angle of 90–100°.

**Attention!**
Tighten conrod bolts knocked in with a hammer to a torque pressure of 60–70 Nm and a torque angle of 90–100° for the first time.



Make sure that this instruction is observed, since otherwise the nuts **of the conrod bolts may** become loose.

**Note:** If no angle of rotation wrench is available, the connecting rod nuts can also be tightened by means of a normal socket wrench with toggle **in one step** by an angle of 90–100°. Estimate angle as accurately as possible. **To eliminate angle faults, do not use a torque wrench** for tightening according to angles of rotation.

**Data**

| | |
|---|---|
| Center of conrod bearing bore to center of conrod bushing bore | 131.950 / 130.050 |
| Width of conrod at conrod bearing bore and conrod bushing bore | 27.890 / 27.857 |
| Basic bore for conrod bearing shells | 51.619 / 51.600 |
| Basic bore for conrod bushing | 26.021 / 26.000 |
| Conrod bushing inside dia. | 23.013 / 23.007 |
| Peak to valley height on inside of conrod bushing | 0.004 |
| Permissible stagger of conrod bore to conrod bushing bore in reference to a length of 100 mm | 0.1 |
| Permissible difference in parallel between axes: conrod bearing bore to conrod bushing bore in reference to a length of 100 mm | dia. 0.015 |
| Permissible deviation of conrod bearing bore from true | 0.020 |
| Permissible difference in weight of all connecting rods of one engine | 5 gr. |

**Tightening torque**

| | | |
|---|---|---|
| Conrod nuts | Initial torque | 40–50 Nm |
| | Torque angle | 90–100° |

**Conventional tool**

| | |
|---|---|
| Connecting rod checking and straightening tool | Made by Krupp GmbH, 5309 Meckenheim e.g. Model CL 6 |

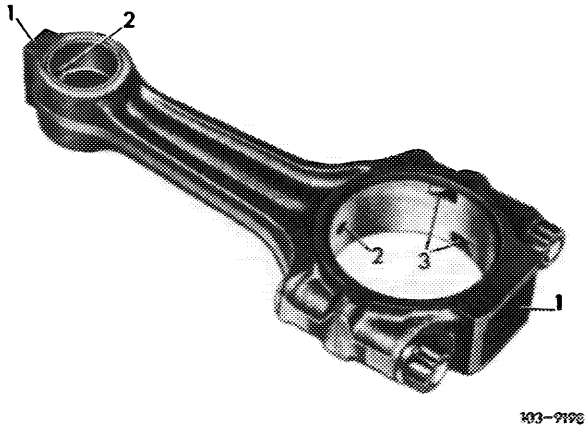
**Note**

Connecting rods, which are overheated (blue discoloration) due to bearing damage, may not be re-used.

The connecting rod and its cap are marked to fit together. The connecting rod stem must not show cross scoring and notches.

Connecting rods with a machined conrod bushing are delivered as replacement parts.

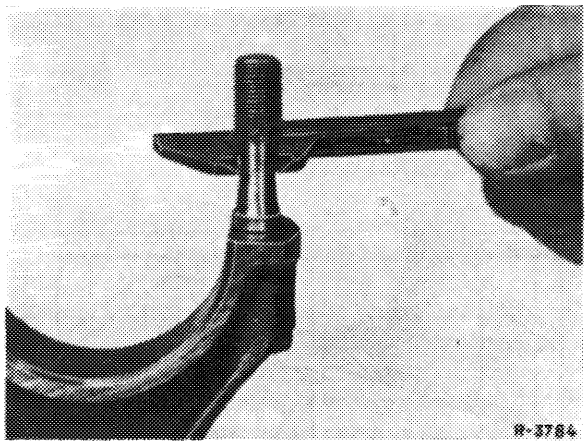
When renewing conrods pay attention to different weights of rods.




103–9198

**Repairing**

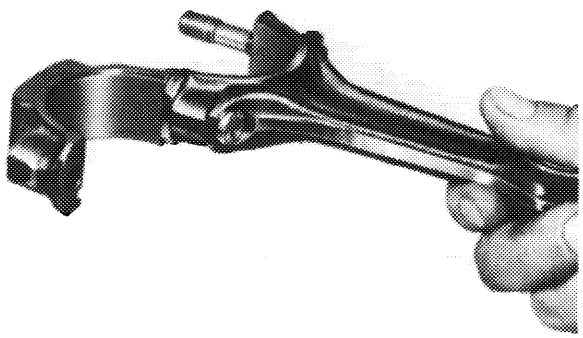
1 Check conrod bolts and replace if necessary (03–310).



8-3784

2 Check conrod bolt bores.

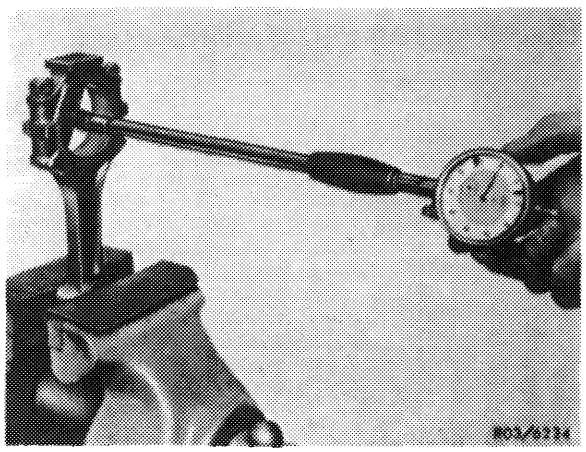
Place conrod cap on a conrod bolt. If the conrod cap moves down by its own weight, the connecting rod must be replaced.



103-9232

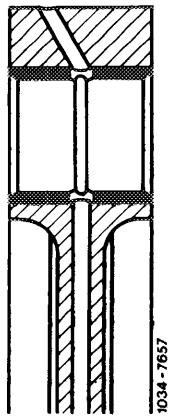
3 Mount connecting rod bearing cap and tighten to 40–50 Nm and 90–100° angle of rotation torque.

4 Measure conrod bearing basic bore. If a basic bore exceeds the value of 51.62 mm or shows conicity, hone bearing surface of bearing cap on a surface plate up to max. 0.02 mm.



5 Press in new conrod bushing that oil bores match.

Installation pressure 2500 Nm.



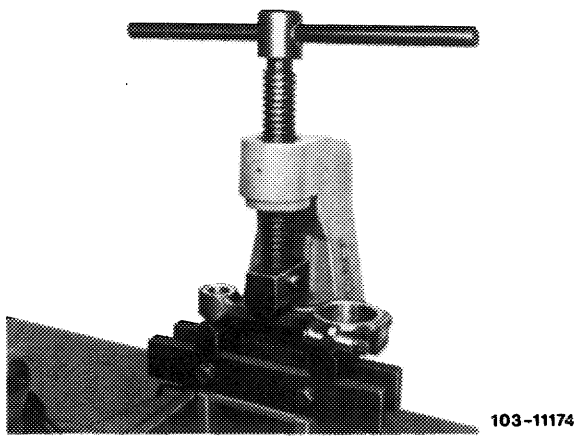

6 Mill or ream out conrod bushing.

7 Hone side bearing surfaces of connecting rod on a surface plate.

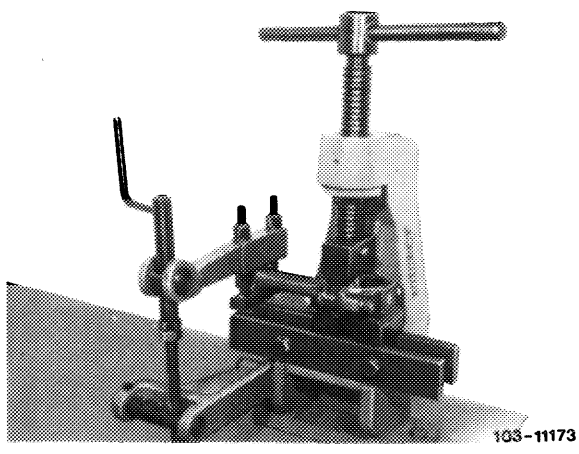
**Squaring**

8 Square connecting rod with a conrod tester.

9 Align parallel of conrod bore to conrod bushing bore.




10 Correct stagger of conrod bore to conrod bushing bore.



**Association piston – cylinder[1])**

| Group number | | 0 | 1 | 2 |
|---|---|---|---|---|
| Standard dimension | Piston dia | 85.970–85.982 | 85.980–85.992 | 85.990–86.002 |
| | Cylinder dia | 85.998–86.008 | 86.009–86.018 | 86.019–86.028 |
| 1st repair stage + 0.5 | Piston dia | 86.470–86.482 | 86.480–86.492 | 86.490–86.502 |
| | Cylinder dia | 86.498–86.508 | 86.509–86.518 | 86.519–86.528 |
| 2nd repair stage + 1.0 | Piston dia | 86.970–86.982 | 86.980–86.992 | 86.990–86.002 |
| | Cylinder dia | 86.998–86.008 | 87.009–87.018 | 87.019–87.028 |

[1]) The smallest measured cylinder dia and the largest measured piston dia are decisive for association.

**Piston code number and piston distance**

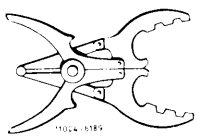
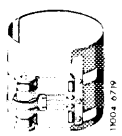
| Engine | | Compression ratio $\epsilon$ : 1 | | Piston code number | Distance between piston crown and cylinder crankcase parting surface |
|---|---|---|---|---|---|
| Normal compression | | | | | |
| 110.921 | 110.983 | | Std | 37, 40, 50, 60, 64, 69 80[1]), 83, 86[1]), 89 | Standback 0.20 to 0.70 |
| 110.922 | 110.984 | | | | |
| 110.923 | 110.985 | | | | |
| 110.924 | 110.986 | 9.0 ± 0.2 | + 0.5 | 38, 41, 51, 67, 70, 84, 90 | Standback 1.0 to 1.50 |
| 110.981 | 110.987 | 8.7 ± 0.2 | | | |
| 110.982 | | | + 1.0 | 39, 42, 52, 68, 71, 85, 91 | |
| Low compression | | | | | |
| 110.921 | 110.984 | | Std | 28, 54, 72, 75 | 0.25 standout up to 0.15 standback |
| 110.922 | 110.985 | | | | |
| 110.923 | 110.991 | 8.0–0.4 | | | |
| 110.924 | | | + 0.5 | 29, 55, 73, 76 | Standback 0.55 to 0.95 |
| 110.931 | 110.992 | | + 1.0 | 30, 56, 74, 77 | |
| 110.932 | 110.993 | | | | |

[1]) Installed in engine 110.984, 110.985, 110.986 and 110.987 as standard equipment. Not available as repair stages. Use only together with piston of same piston code number.

| Test values | | New (Installation tolerance) | Wear limit |
|---|---|---|---|
| Piston clearance | | 0.016 to 0.040 | 0.08 |
| Difference in weight of pistons in one engine | | 4 g | 10 g |
| Piston pin dia. | | 22.996 to 23.00 | |
| Piston pin clearance | in conrod bushing | 0.007 to 0.017 | |
| | in piston | 0.002 to 0.011 | |
| Piston ring gap | groove 1 | 0.30 to 0.45 | 1.0 |
| | groove 2 | 0.30 to 0.45 | 0.8 |
| | groove 3 | 0.25 to 0.40 | 0.8 |
| Piston ring clearance | groove 1 | 0.05 to 0.08 | 0.15 |
| | groove 2 | 0.03 to 0.06 | 0.08 |
| | groove 3 | 0.01 to 0.04 | 0.08 |

| Tightening torque | | |
|---|---|---|
| Connecting rod nuts | torque pressure | 40–50 Nm |
| | torque angle | 90–100° |

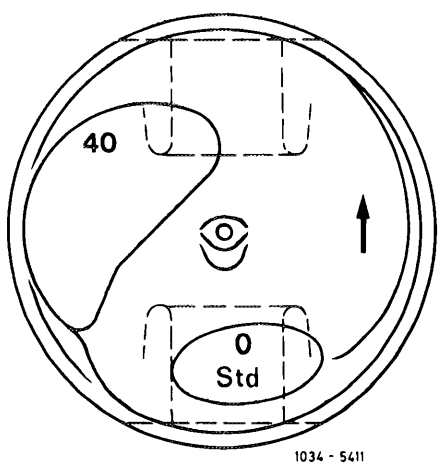
**Special tools**

| | | |
|---|---|---|
| Piston ring pliers |  | 000 589 51 37 00 |
| Piston ring compressor |  | 000 589 04 14 00 |

**Note**

The piston version (std, + 0.5 or + 1.0), the group number (0, 1 or 2), the piston code (e.g. 40) and an arrow for forward direction are stamped in the piston crown.

The group number is also stamped in the crankcase mating surface.



The group number of pistons (e.g. 1) is the same as the group number of cylinder bores (production).

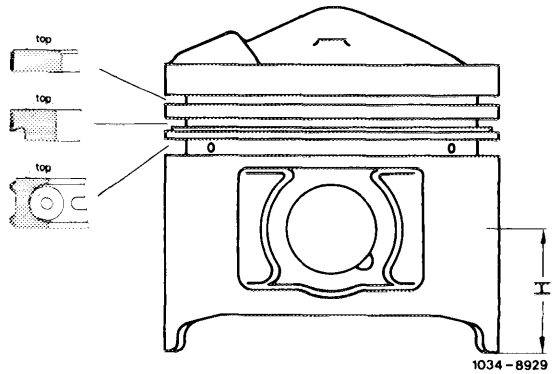
This will guarantee the specified piston clearance.

When repairing, the cylinder bores should be honed according to the sizes of the existing pistons plus the piston clearance.

Pistons and piston pins are matched.

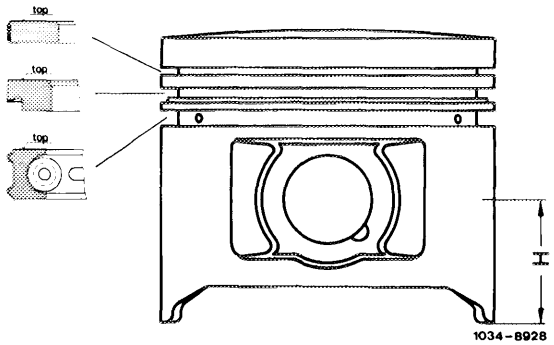
The measuring point for nominal diameter of pistons is offset by 90° in relation to piston pin axis at level H.

On used pistons the measured value does not necessarily correspond with nominal diameter of a new piston, since piston in range of measuring point and at shaft tab may "recede" already after a short operating period, that is, the nominal diameter may become smaller by up to 0.070 mm.




Piston normal compression
dimension H = 32 mm

If used pistons are used again, make sure that the oil drain bores in 3rd piston ring groove are cleaned.




Piston low compression and
USA version
dimension H = 32 mm

**Removal**

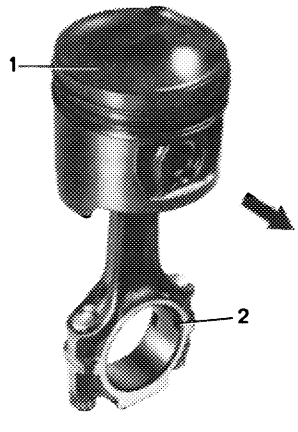
1 Take out connecting rod with piston from above.

2 Remove piston pin circlips and press out piston pin.

3 Repair and square connecting rod (03–313).

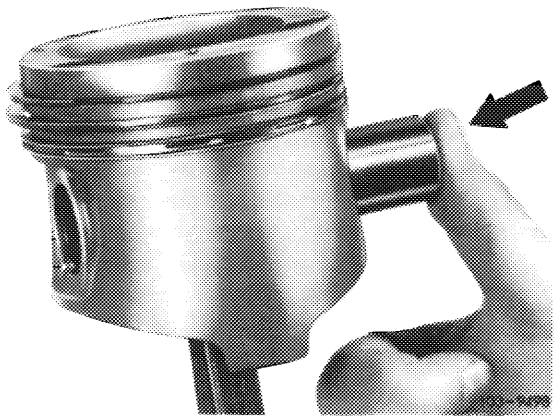
## Installation

4 Place piston on connecting rod that arrow (1) faces in forward direction and circlip grooves (2) in connecting rod face to left side of engine (intake manifold).




**Attention!**
Don't heat piston.

5 Press in piston pin coated with engine oil **by hand.**

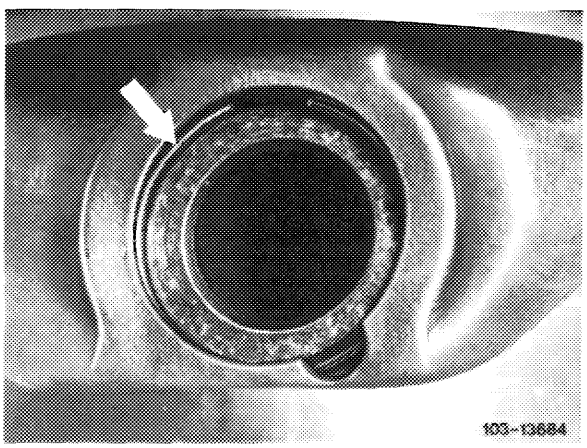


6 Insert piston pin circlips in grooves.

When installing used pistons, check piston ring gaps and clearances.

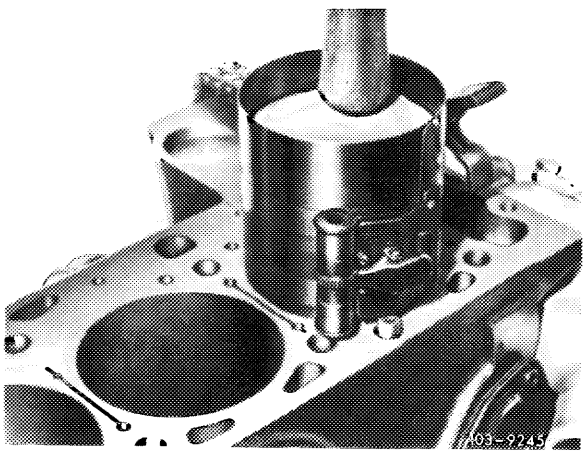
Check piston rings for easy movement.

7 Lubricate cleaned cylinder bores, conrod bearing journals, conrod bearing shells and the pistons.




8 Distribute gaps of piston rings around piston circumference evenly.

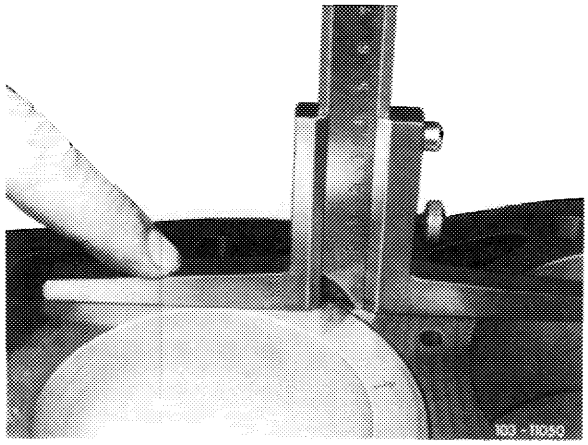
9 Install piston ring compressor and guide in piston with arrow facing forward.



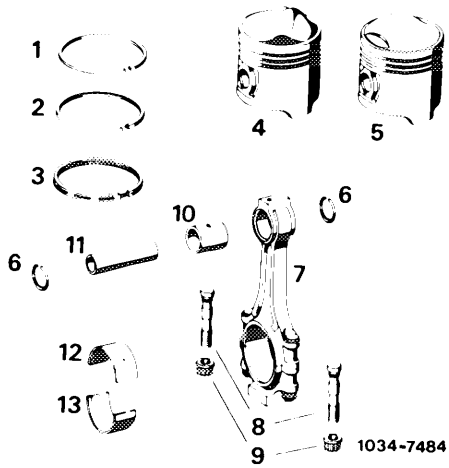
10 Place connecting rod bearing caps with code numbers facing each other on connecting rod and tighten connecting nuts to 40–50 Nm initial torque and to 90–100° angle of rotation torque.

11 Turn crankshaft and check clearance between piston pin boss and connecting rod.

12 Measure distance between piston crown and crankcase mating surface when piston is positioned at TDC (see chart).



## Pistons and connecting rods




1 Plain compression ring
2 Oil scraper ring
3 Bevelled compression ring with hose lined spring
4 Piston
5 Piston, USA and low compression
6 Circlip
7 Connecting rod with conrod cap
8 Conrod bolt
9 Nut
10 Conrod bushing
11 Conrod pin
12 Conrod bearing upper half with oil bore
13 Conrod bearing lower half

**Data**

| Crankshaft Standard size & undersizes | Crankshaft bearing journal dia. | Width of journal at thrust bearing | Conrod bearing journal dia. | Conrod bearing journal width |
|---|---|---|---|---|
| Standard size | 59.96<br>59.95 | 29.00<br>29.02 | 47.96<br>47.95 | 28.00<br>28.08 |
| 1st Undersize | 59.71<br>59.70 | to 29.60 | 47.71<br>47.70 | to 28.30 |
| 2nd Undersize | 59.46<br>59.45 | | 47.46<br>47.45 | |
| 3rd Undersize | 59.21<br>59.20 | | 47.21<br>47.20 | |
| 4th Undersize | 58.96<br>58.95 | | 46.96<br>46.95 | |

| | | |
|---|---|---|
| Crankshaft journal dia. for mounting compensating weight | | 0.030 |
| Permissible deviation of crankshaft journal prior to mounting compensating weight | from cyl. shape | 0.005 |
| | from true[1)] | 0.030 |
| Permissible deviation of crank pins and crankshaft bearing journals from true | | 0.0025 |
| Permissible deviation of crank pin cyl. line from parallel | | 0.010 |
| Permissible deviation of running surfaces of fitted bearing from parallel[1)] | | 0.020 |
| Permissible deviation of running surface of rear radial sealing ring from concentric true[1)] | | 0.015 |
| Permissible deviation of flywheel flange from axial true[1)] | | 0.010 |
| Permissible deviation of crankshaft bearing journal from concentric true[1)] | journal II, VI | 0.070 |
| | journal III, IV, V | 0.100 |
| Fillets on crankshafts and crank pins | | 2.5 to 3 |

| | | |
|---|---|---|
| Scleroscope hardness of crankshaft bearing journals and crank pins | when new | 74–84 |
| | boundary value | 60[2] |
| Permissible unbalance of crankshaft | | 15 cmg |

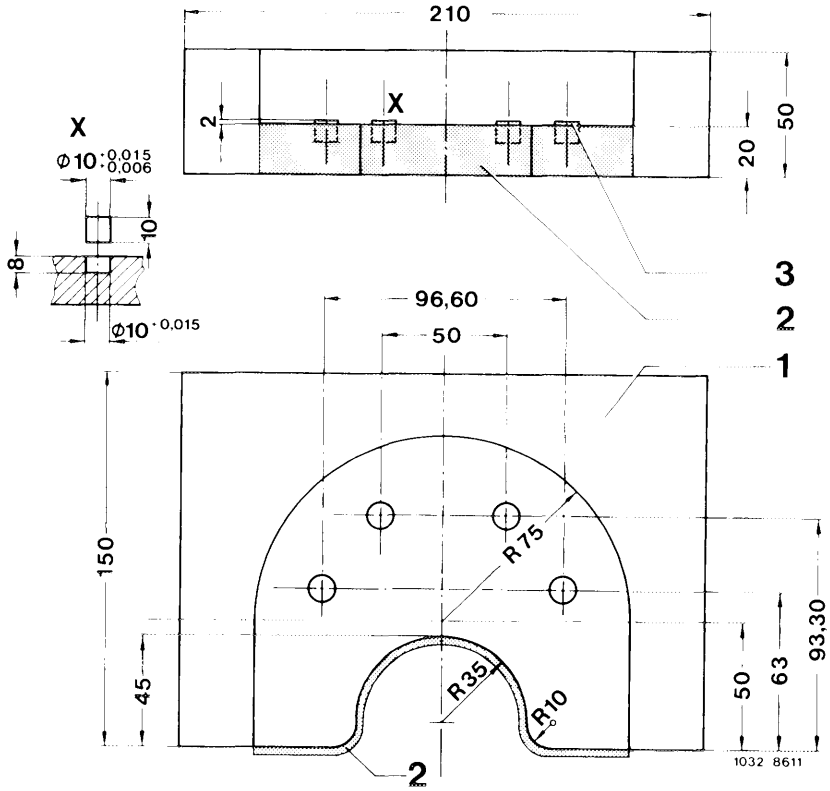
1) When mounting crankshaft on outer crankshaft bearing journal I and VII after one full turn.
2) Boundary value should be available at min. 2/3 of journal circumference.

**Special tool**

| | | |
|---|---|---|
| Impact hardness tester | | 000 589 20 21 00 |

**Self-made tool**

Rivet support for riveting counterweight to crankshaft.



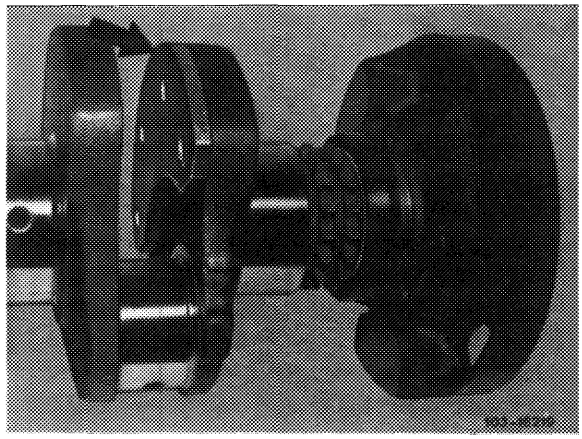
**Note**

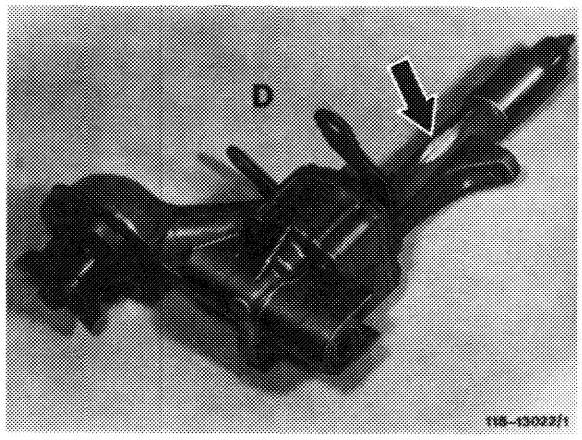
Since December 1978, the crankshaft of engine 110 is provided with an additional weight.
Remove additional weight when machining first crank pin.
After machining crank pin, rivet additional weight on again. Then check crankshaft for runout, and balance together with flywheel and balancing disc, also when re-using the old additional weight.

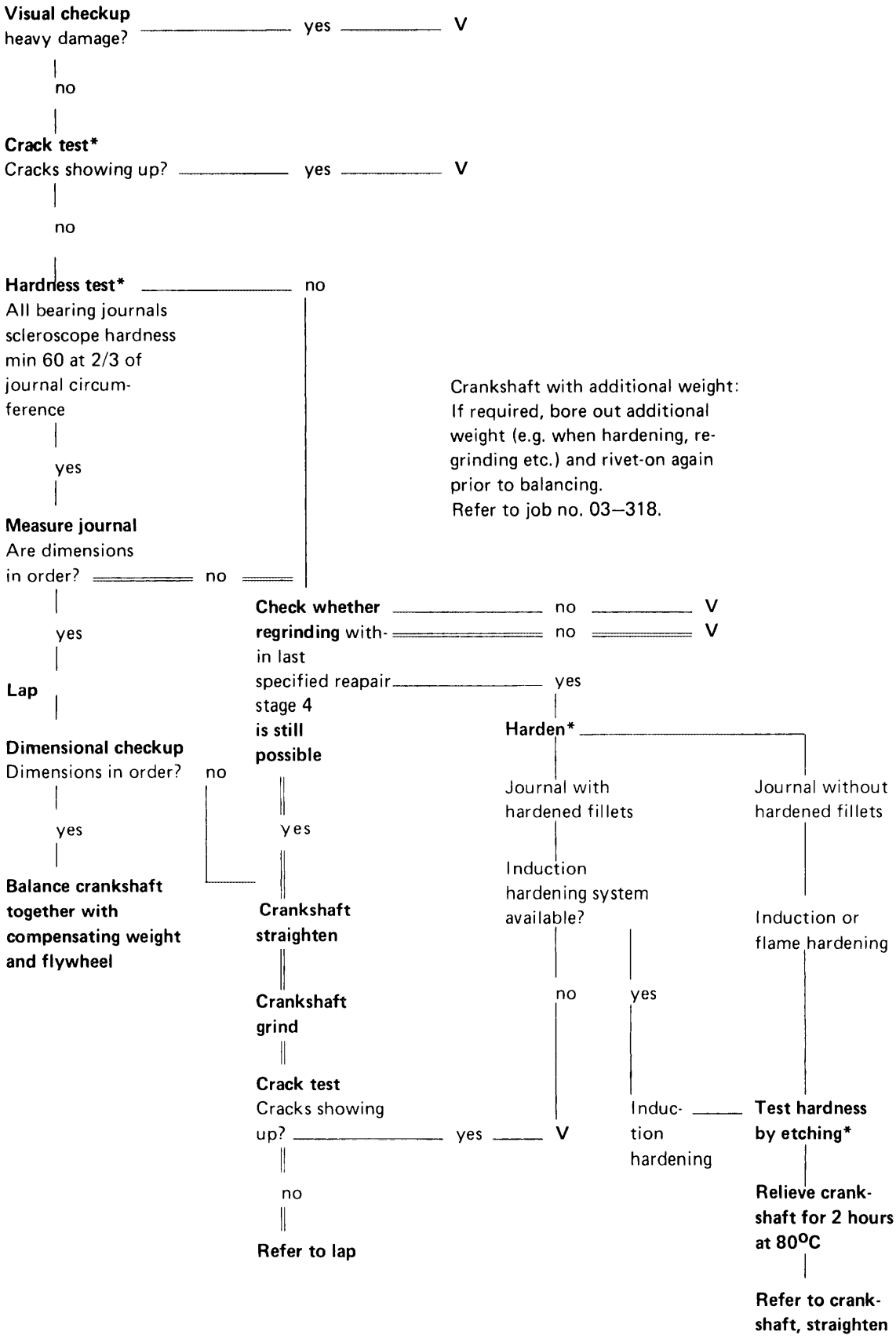
The crankshaft with riveted-on additional weight may be used only together with a modified oil pump which is provided with a recess (arrow) on housing shaft.

When checking and reconditioning crankshafts, proceed in sequence of the following diagram and pertinent explanations.

For grinding crank pins, a difference of only one repair stage per crankshaft is permitted.






Visual checkup
heavy damage?
yes
V
no
Crack test*
Cracks showing up?
yes
V
no
Hardness test*
no
All bearing journals scleroscope hardness min 60 at 2/3 of journal circum-ference
yes
Measure journal
Are dimensions in order?
no
yes
Lap
Dimensional checkup
Dimensions in order?
no
yes
Balance crankshaft together with compensating weight and flywheel
Crankshaft with additional weight: If required, bore out additional weight (e.g. when hardening, re-grinding etc.) and rivet-on again prior to balancing.
Refer to job no. 03–318.
Check whether regrinding within last specified reapair stage 4 is still possible
no
V
no
V
yes
yes
Crankshaft straighten
Crankshaft grind
Crack test
Cracks showing up?
yes
V
no
Refer to lap
Harden*
Journal with hardened fillets
Induction hardening system available?
no
yes
Induc-tion hardening
Journal without hardened fillets
Induction or flame hardening
Test hardness by etching*
Relieve crank-shaft for 2 hours at 80°C
Refer to crank-shaft, straighten

## Explanations concerning diagram

### Crack test

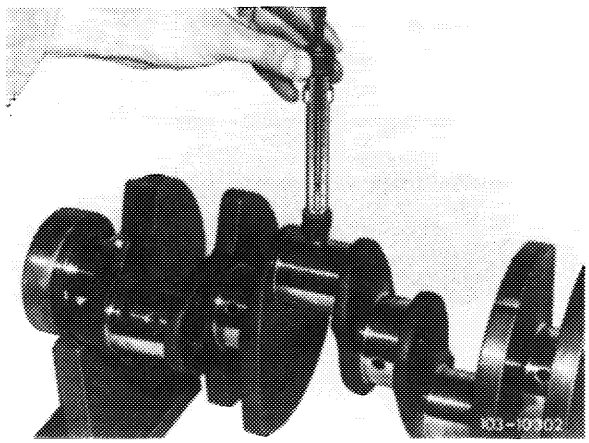
Clean crankshaft. Bearing journals should be free of oil and grease. Magnetize crankshaft and apply fluorescent powder (flux). A color penetration method (insertion in bath or with spray can) can also be applied.

Aids: paint or fluorescent powder,
cleaning agent,
developer.

### Hardness test

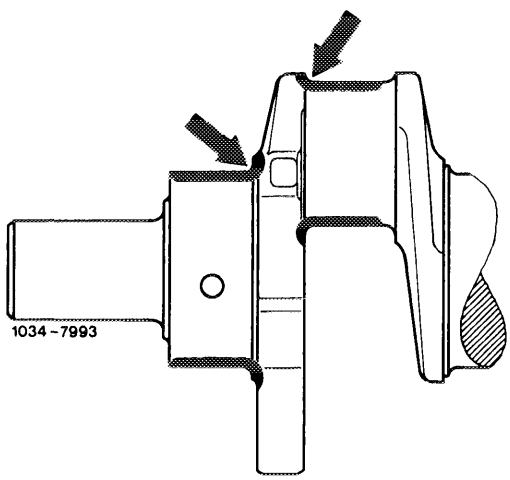
Test hardness with impact hardness tester (scleroscope hardness).

Scleroscope hardness of 60 should be available at 2/3 of journal circumference.

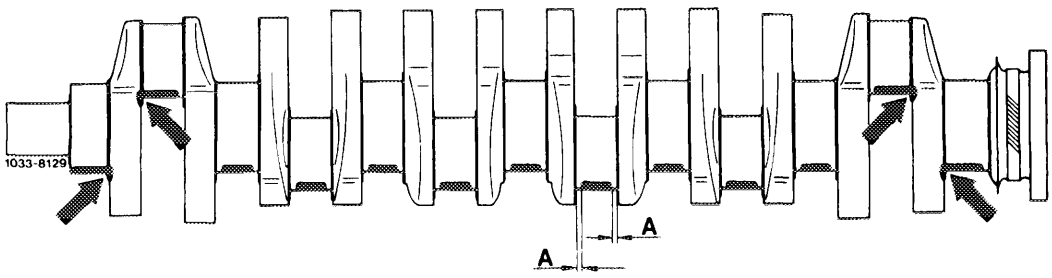


### Hardening

Journals without hardened fillets can be hardened inductively or by flame hardening. Journals with hardened fillets (arrows) should be inductance-hardened on principle. If this is not possible, scrap crankshaft.




When hardening journals without hardened fillets, maintain distance A between runout of hardened surface and fillet (4–5 mm).



## Checking hardening procedure

For a good hardening job, test adjustment of hardening plant by metallographic grinding tests.

These tests can be made by testing scrapped crankshafts.

Check hardening by etching surface of journal with a 2% alcoholic nitric acid ($HNO_3$).

No dark spots should show up at surface of journal.

Non-hardened fillets will become dark.

The hardened fillets, on the other hand, should be as bright as surface of journal.

For comparison, perform an etching job on a metallographically controlled journal.

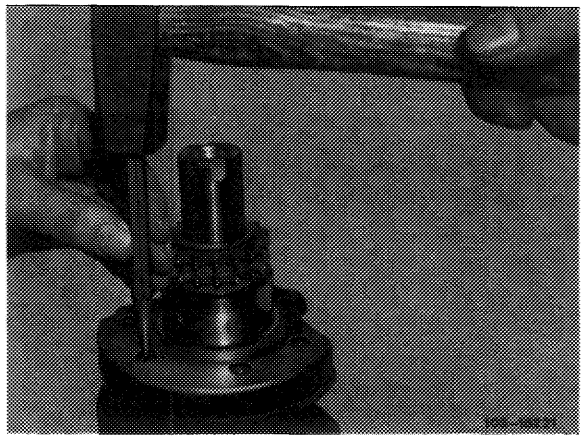
Then, carefully wash off nitric acid by means of alcohol.

## Corrosion protection

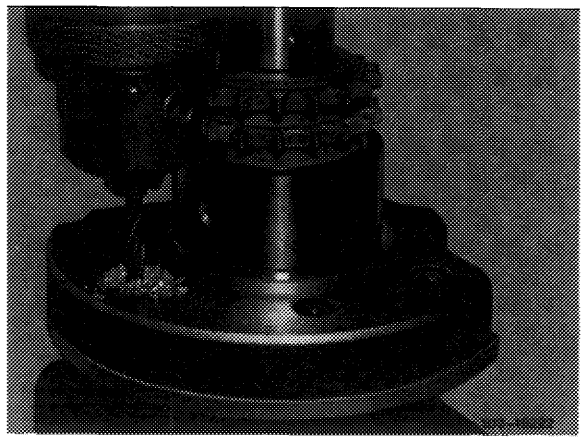
Crankshafts which are not immediately installed again should be lubricated with engine initial operation oil (SAE 30).

## Riveting additional weight off and on

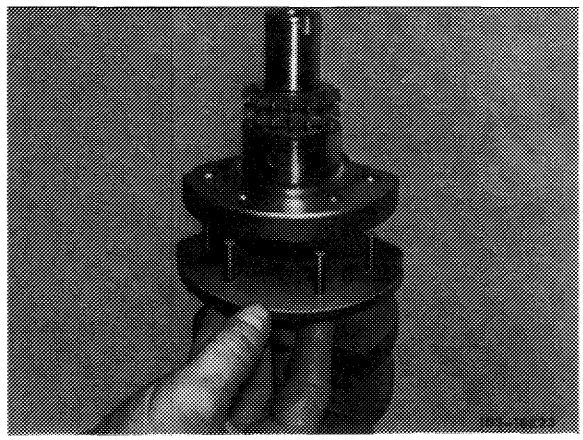
1 Punch mark countersunk rivet 6 x 28 mm accurately in center.



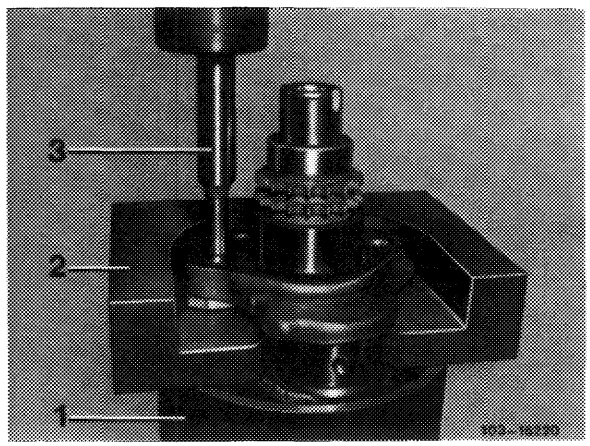
2 Drill into rivet heads with a 6.5 mm dia. drill and knock out.



3 Slip-on new or former, undamaged additional weight together with 4 countersunk rivets.



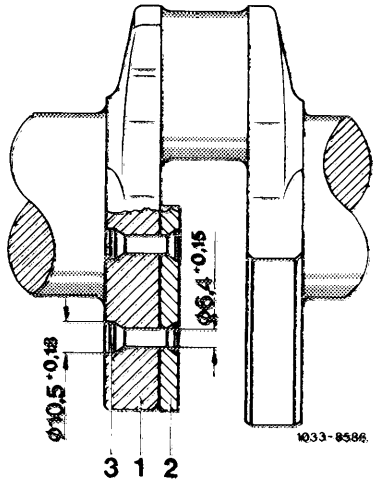
4 Introduce crankshaft into a suitable steel tube (approx. 165 mm dia. x 420 mm long) and place self-made rivet support (2) underneath.




1 Steel tube 165 mm dia. x 420 mm long
2 Self-made rivet support
3 Snap die

5 Rivet countersunk rivet by means of a hydraulic press. The additional weight should then rest fully against crankshaft cheek without leaving any intermediate space.

6 Then check crankshaft for runout of bearing journals and balance together with balancing disc and flywheel, even if the former additional weight is used again.




1 Crankshaft
2 Additional weight 110 031 05 01
3 Countersunk rivet 6 x 28 mm DIN 661 MUSt 34

**Series production of riveted-on additional weight starting December 1978**

| starting engine end no. | starting chassis end no. |
|---|---|
| 110.992 –10–038 031<br>–12–062 390 | 116.020–112 253 |
| 110.923 –10–012 665<br>–12–015 613 | 123.030–025 675<br>123.050–002 801 |
| 110.932 –10–009 748<br>–12–002 556 | 116.020–112 253 |
| 110.984 –10–014 634<br>–12–051 160 | 123.033–050 600<br>123.053–013 292 |
| 110.984 –10–014 634<br>–12–051 160 | 123.093–001 229 |
| 110.985 –10–011 106<br>–12–052 660 | 116.024/025–131 270 |
| 110.986 –10–002 276<br>–12–005 142 | 107.022–006 288<br>107.042–005 285 |

**Data**

| Crankshaft standard dimension and repair stages | Crankshaft bearing journal dia | Width of journal on fitted bearing | Crankpin dia | Width of crankpin |
|---|---|---|---|---|
| Standard dimension | 59.965 / 59.955 | 29.021 / 29.000 | 47.965 / 47.955 | 28.084 / 28.000 |
| 1st repair stage | 59.715 / 59.705 | up to 29.60 | 47.715 / 47.705 | up to 28.30 |
| 2nd repair stage | 59.465 / 59.455 | | 47.465 / 47.455 | |
| 3rd repair stage | 59.215 / 59.205 | | 47.215 / 47.205 | |
| 4th repair stage | 58.965 / 58.955 | | 46.965 / 46.955 | |

| Basic bore and bearing play | | Crankshaft bearing | Connecting rod bearing |
|---|---|---|---|
| Basic bore dia | | 67.00 / 67.02 | 51.60 / 51.62 |
| Perm. out-of-round and conicity of basic bore | | 0.01 | |
| Radial bearing play | when new | 0.031 to 0.053[1)] | 0.025 to 0.065[1)] |
| | wear limit | 0.08 | |
| Axial bearing play | when new | 0.10–0.24 | 0.11–0.23 |
| | wear limit | 0.30 | 0.50 |

[1)] Try for mean value of radial play (vertical runout).

| Bearing shells | Wall thickness crankshaft bearing | Width of fitted bearing shells | Wall thickness connecting rod bearing |
|---|---|---|---|
| Standard dimension | 3.500–3.513 | 28.78–28.90 | 1.804–1.814 |
| 1st repair stage | 3.625–3.638 | 29.4–29.6[3)] | 1.929–1.939 |
| 2nd repair stage | 3.750–3.763 | | 2.054–2.064 |
| 3rd repair stage | 3.875–3.888 | | 2.179–2.189 |
| 4th repair stage | 4.000–4.013 | | 2.304–2.314 |

1) Measured at apex of bearing shell.
2) The fitted bearing shells for 1st to 4th repair stage are supplied in oversize width and should be refinished in accordance with ground crankshaft bearing journal.